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## (54) CDMA base station apparatus and code assignment method

(57) Code reading section 44 reads code specification information stored in all code list 42 and interference level measuring section 30 measures the interference level of each code, threshold determination section 45 selects the code specification information whose interference level is smaller than a preset threshold and stores it in code candidate list 43 and code determination section 46 determines the code specification information of said station from the selected code specification information pieces. When adding a new base station, this makes it possible to automatically determine said station code, eliminating the need for theoretical design for assigning codes to all base stations.

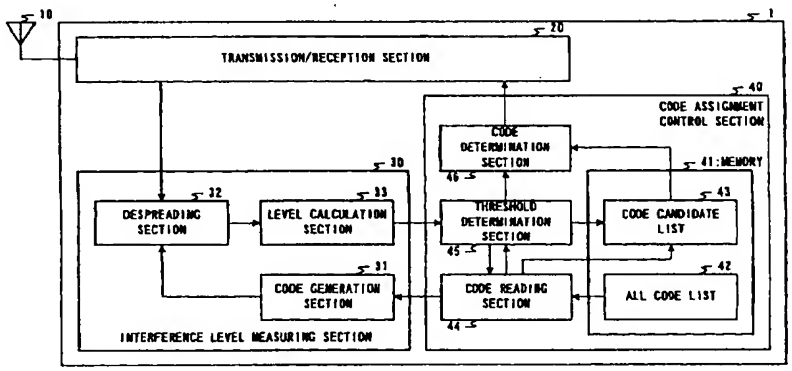


FIG. 1

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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** The present invention relates to a base station apparatus used in a CDMA-based radio communication system and its code assignment method.

#### Description of the Related Art

**[0002]** A CDMA-based base station apparatus (hereinafter simply referred to as "base station") presets code specification information specific to each apparatus, generates codes based on this code specification information and transmits signals multiplied by those codes. The code specification information is code phase for a PN code, etc. and code type for a Walsh code, etc.

**[0003]** In a conventional method of assigning codes to base stations, code specification information is fixedly assigned through advance theoretical design to base stations preventing them from interfering with one another.

**[0004]** However, if a new base station is added, the conventional method of assigning codes to base stations above has a problem of having the necessity of repeating theoretical design to assign codes to all base stations once again.

### SUMMARY OF THE INVENTION

**[0005]** It is an objective of the present invention to provide a CDMA base station apparatus and code assignment method that will not require theoretical design to assign codes to all base stations even if a new base station is added.

**[0006]** The present invention achieves the objective above by reading stored code specification information and measuring its interference level, selecting code specification information whose interference level is smaller than a preset threshold as its own code information candidate and determining the code specification information of the station from the selected code specification information.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection with the accompanying drawing wherein one example is illustrated by way of example, in which;

FIG.1 is a block diagram showing a configuration of a base station in Embodiment 1 of the present invention;
FIG.2 is a flow diagram showing code assignment operation of the base station in Embodiment 1;
FIG.3 is a block diagram showing a configuration of a base station in Embodiment 2;
FIG.4 is a flow diagram showing code assignment operation of the base station in Embodiment 2;
FIG.5 is a block diagram showing a configuration of a base station in Embodiment 3;
FIG.6 is a flow diagram showing code assignment operation of the base station in Embodiment 3;
FIG.7 is a flow diagram showing a priority update operation of the base station in Embodiment 3;
FIG.8 is a block diagram showing a configuration of a base station in Embodiment 4;
FIG.9 is a flow diagram showing code assignment operation of the base station in Embodiment 4;
FIG.10 is a flow diagram showing a priority update operation of a base station in Embodiment 5;
FIG.11 is a block diagram showing a configuration of a base station in Embodiment 6;
FIG.12 is a flow diagram showing code assignment operation of the base station in Embodiment 6;
FIG.13 is a block diagram showing a configuration of a base station in Embodiment 7;
FIG.14 is a flow diagram showing code assignment operation of the base station in Embodiment 7;
FIG.15 is a flow diagram showing code assignment operation of the base station in Embodiment 7;
FIG.16 is a flow diagram showing code assignment operation of a base station in Embodiment 8;
FIG.17 is a flow diagram showing code assignment operation of a base station in Embodiment 9;
FIG.18 is a block diagram showing a configuration of a base station in Embodiment 10;
FIG.19 is a flow diagram showing code assignment operation of a base station in Embodiment 10;
FIG.20 is a system diagram showing a radio communication system including the CDMA base station apparatus of the present invention.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0008]** With reference now to the attached drawings, the embodiments of the present invention are explained in detail below. In the explanations below, code type is used as code specification information.

(Embodiment 1)

**[0009]** FIG.1 is a block diagram showing a configuration of a base station in Embodiment 1 of the present invention. Base station 1 in FIG.1 mainly comprises transmission/reception section 20 that transmits/receives signals to/from a mobile station and receives a signal transmitted from another base station via antenna 10, interference level measuring section 30 that measures the interference level of a signal received by transmission/reception section 20 and code assign-



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ment control section 40 that performs code type assignment control based on the measured interference level.

**[0010]** Code assignment control section 40 comprises memory 41 that stores code types and memory 41 comprises all code list 42 that stores all code types in a list form and candidate code list 43 that stores code types to be assignment candidates in a list form.

**[0011]** Code assignment control section 40 also comprises code reading section 44 that reads code types from all code list 42 and outputs them to interference level measuring section 30, threshold determination section 45 that determines a code type to be an assignment candidate based on the interference level input from interference level measuring section 30 and a preset threshold and writes the code type to be an assignment candidate to candidate code list 43 and code determination section 46 that determines the code type of the station to be used from candidate code list 43 and outputs it to transmission/reception section 20.

**[0012]** Interference level measuring section 30 comprises code generation section 31 that generates codes based on a code type input from code reading section 44, despreading section 32 that despreads a received signal multiplied by a code and level calculation section 33 that calculates the interference level of the despread signal.

**[0013]** Then, the code assignment operation of base station 1 in Embodiment 1 is explained using a flow diagram in FIG.2.

**[0014]** When base station 1 determines the code type of the station, the sections of the apparatus such as candidate code list 43 are initialized (ST201), and code reading section 44 reads one code type to be searched from all code list 42 and outputs it to code generation section 31 of interference level measuring section 30 (ST202).

**[0015]** Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST203). To be more specific, code generation section 31 generates a code based on the input code type, despreading section 32 despreads the signal with the code generated and level calculation section 33 calculates the level of the despread signal.

**[0016]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST204) and if the interference level is lower than the threshold, the corresponding code type is written to candidate code list 43 (ST205).

**[0017]** After the operations from ST202 to ST205 are carried out on all code types stored in all code list 42 (ST206), code determination section 46 determines the code type of the station from among the code types stored in candidate code list 43 (ST207).

**[0018]** Thus, by measuring the interference level for each code type, storing code types whose interference level is lower than the threshold in the candidate code list and determining the code type of the station, it is possible to eliminate the need for additional code assignment design when a new base station is added, for example.

**[0019]** As a method of determining the code type of the station it is also possible to store not only code types but also interference levels in the candidate code list and determine the code type with the lowest interference level as the code type of the station. This allows communications with the code type of the best communication quality.

**[0020]** Moreover, as another method of determining the code type of the station it is also possible to store not only code types but also interference levels in the candidate code list and determine the code type with the highest interference level as the code type of the station. This makes it possible to improve the efficiency of repetitive use of a same code type and efficiently arrange base stations.

(Embodiment 2)

**[0021]** Embodiment 2 is an embodiment giving priority to previously used codes in code assignment operation. FIG.3 is a block diagram showing a configuration of a base station in Embodiment 2.

**[0022]** When carrying out code assignment operation, code reading section 44 in base station 1 in FIG.3 reads a previously used code type of the station which is held in code determination section 46. If the interference level of the previously used code type of the station is lower than a threshold, threshold determination section 45 outputs the code type to code determination section 46. When the code type is input from threshold determination section 45, code determination section 46 outputs the code type to transmission/reception section 20 as the code type of the station. The other components in base station 1 in FIG.3 are the same as those in FIG.1, and thus they are assigned the same numbers and their explanations are omitted.

**[0023]** Then, the code assignment operation of the base station in Embodiment 2 is explained using a flow diagram in FIG.4.

**[0024]** When base station 1 determines the code type of the station, the sections of the apparatus such as candidate code list 43 are initialized (ST401), and then code reading section 44 reads the previously used code type from code determination section 46 and outputs it to code generation section 31 of interference level measuring section 30 (ST402). Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST403).

**[0025]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST404) and if the interference level is lower than the threshold, the previously used code type is output to code determination section 46 and code determination section 46 determines the code type as the code type of



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the station (ST405).

**[0026]** The subsequent operation when the interference level of the previously used code type is higher than the threshold is the same as the operations from ST202 to ST207 in the flow diagram in FIG.2, and thus their explanations are omitted.

**[0027]** As seen above, preferentially using the previously used codes eliminates the need for measuring the interference level of other code types when the interference level of the previously used code type of the station is lower than a threshold, making it possible to shorten the time required for code assignment operation.

(Embodiment 3)

**[0028]** Embodiment 3 is an embodiment that counts the number of times the interference level measured during a communication was lower than a threshold, determines priority based on the counted value and preferentially uses codes with high priority in code assignment operation. FIG.5 is a block diagram showing a configuration of a base station in Embodiment 3.

**[0029]** In the base station in FIG.5 compared to base station 1 in FIG.1, memory 41 only comprises all code list 42 and all code list 42 stores not only code types but also the number of times (hereinafter referred to as "count value") the interference level measured during a communication of each code type was lower than the threshold.

**[0030]** Threshold determination section 45 incorporates a counter and if the interference level of the code type measured during a communication was lower than the threshold, it increments the counter and stores the count value together with the code type in all code list 42. Furthermore, threshold determination section 45 treats a code type with a higher count value as one with higher priority and sorts all code types in all code list 42 in descending order of priority.

**[0031]** Code reading section 44 measures time with a built-in timer and reads the assigned code type of the station stored in code determination section 46 at regular intervals from the beginning of the communication. When carrying out code assignment operation, code reading section 44 reads code types from all code list 42 in descending order of priority.

**[0032]** Level calculation section 33 subtracts the power level of the station input from transmission/reception section 20 from the interference level including the transmission power of the station calculated from the despread signal during the communication and calculates the true interference level.

**[0033]** The other components of base station 1 in FIG.5 are the same as those in FIG.1, and so they are assigned the same numbers as those in FIG.1 and their explanations are omitted.

**[0034]** Then, the code assignment operation of the base station in Embodiment 3 is explained using a flow diagram in FIG.6.

**[0035]** When base station 1 determines the code type of the station, the sections of the apparatus such as the timer of code reading section 44 are initialized (ST601), code reading section 44 reads the code types whose interference level has not been measured yet with the highest priority and outputs it to code generation section 31 of interference level measuring section 30 (ST602) and interference level measuring section 30 measures the level of an interference component of the received signal (ST603).

**[0036]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST604) and if the interference level is lower than the threshold, the code type is output to code determination section 46 and code determination section 46 determines the code type as the code type of the station (ST605). If the interference level is higher than the threshold in ST604, the operations from ST602 are repeated once again.

**[0037]** The priority update operation during a communication of base station 1 in Embodiment 3 is explained using a flow diagram in FIG.7.

**[0038]** When base station 1 starts a communication, the timer of code reading section 44 starts (ST701). If a measurement continues for a certain period of time (ST703) without power interruption (ST702), the timer is reset (ST704), and code reading section 44 reads the assigned code type of the station from code determination section 46 and outputs it to code generation section 31 of interference level measuring section 30 (ST705).

**[0039]** Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST706). To be more specific, code generation section 31 generates a code based on the input code type, despreading section 32 despreads the signal with the code generated and level calculation section 33 subtracts the power level of the station input from transmission/reception section 20 from the interference level including the transmission power of the station calculated from the despread signal and calculates the true interference level.

**[0040]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST707) and if the interference level is lower than the threshold, the built-in counter of threshold determination section 45 is incremented (ST708) and the count value in all code list 42 is corrected (ST709).

**[0041]** A code type with a higher count value is treated as one with higher priority and all code types in all code list 42 are sorted in descending order of priority (ST710).

**[0042]** As seen above, by counting the number of times the assigned code type of the station during a communication was lower than the interference level, treating a code type with a higher count value as one



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with higher priority and measuring the interference level of code types in descending order of priority, it is possible to efficiently specify the code types whose interference level is lower than the threshold and shorten the time required for code assignment operation.

(Embodiment 4)

**[0043]** Embodiment 4 is an embodiment that determines priority based on the measured interference level and preferentially uses codes with higher priority in code assignment operation. FIG.8 is a block diagram showing a configuration of a base station in Embodiment 4. In the base station in FIG.8 compared to base station 1 in FIG.1, memory 41 only comprises all code list 42 and all code list 42 stores code types as well as the interface level of each code type.

**[0044]** Threshold determination section 45 treats a code type with a lower interference level as one with higher priority and sorts all code types in all code list 42 in descending order of priority. When carrying out code assignment operation, code reading section 44 reads code types from all code list 42 in descending order of priority.

**[0045]** The other components of base station 1 in FIG.8 are the same as those in FIG.1, and so they are assigned the same numbers as those in FIG.1 and their explanations are omitted.

**[0046]** Then, the code assignment operation of the base station in Embodiment 4 is explained using a flow diagram in FIG.9.

**[0047]** When base station 1 determines the code type of the station, the sections of the apparatus are initialized (ST901), code reading section 44 reads the code type with the highest priority whose interference level has not been measured yet and outputs it to code generation section 31 of interference level measuring section 30 (ST902) and interference level measuring section 30 measures the level of an interference component of the received signal (ST903).

**[0048]** Then, threshold determination section 45 updates the stored interference level to the interference level measured by interference measuring section 30 (ST904) and at the same time compares the interference level measured by interference level measuring section 30 with a preset threshold (ST905).

**[0049]** If the interference level is lower than the threshold, the code type is output to code determination section 46 and code determination section 46 determines the code type as the code type of the station (ST906) and treats a code type with a lower interference level as one with higher priority and sorts all code types in all code list 42 in descending order of priority (ST907). In ST905, if the interference level is higher than the threshold, the operations from ST902 are repeated once again.

**[0050]** Thus, by treating assigned code types with a higher interference level measured as ones with higher priority and measuring the interference level of code types in descending order of priority in code assignment operation, it is possible to efficiently specify code types whose interference level is lower than the threshold and shorten the time required for code assignment operation.

(Embodiment 5)

**[0051]** Embodiment 5 is an embodiment that measures the interference level of the assigned code of the station during a communication, determines priority based on the interference level measured and preferentially uses codes with higher priority in code assignment operation.

**[0052]** The configuration of a base station in Embodiment 5 is the same as that in FIG.5 and the code assignment operation at the base station in Embodiment 5 is the same as that in Embodiment 4, and so their explanations are omitted.

**[0053]** The priority update operation during a communication of the base station in Embodiment 5 is explained using a flow diagram in FIG.10.

**[0054]** When base station 1 starts a communication, the timer of code reading section 44 starts (ST1001). If a measurement continues for a certain period of time (ST1003) without power interruption (ST1002), the timer is reset (ST1004), and code reading section 44 reads the assigned code type of the station from code determination section 46 and outputs it to code generation section 31 of interference level measuring section 30 (ST1005).

**[0055]** Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST1006). To be more specific, code generation section 31 generates a code based on the input code type, despreading section 32 despreads the signal with the code generated and level calculation section 33 subtracts the power level of the station input from transmission/reception section 20 from the interference level including the transmission power of the station calculated from the despread level and calculates the true interference level.

**[0056]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST1007) and if the interference level is higher than the threshold, the interference level is considered to be the threshold (ST1008) and the interference level in the corresponding code type in all code list 42 is updated to the threshold (ST1009). If the interference level is lower than the threshold, the interference level in the corresponding code type in all code list 42 is updated to the measured interference level (ST1009).

**[0057]** A code type with a higher interference level is treated as one with higher priority and all code types in all code list 42 are sorted in order of priority (ST1010).

**[0058]** As seen above, by determining priority with ref-



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erence to the interference level of the assigned code type of the station during a communication in addition to the interference level in code assignment operation and measuring the interference level of code types in descending order of priority in code assignment operation, it is possible to efficiently specify the code types whose interference level is lower than the threshold and shorten the time required for code assignment operation.

(Embodiment 6)

**[0059]** Embodiment 6 is an embodiment that determines priority based on a count value indicating the frequency of use and preferentially uses codes with higher priority in code assignment operation. FIG.11 is a block diagram showing a configuration of a base station in Embodiment 6. In the base station in FIG.11, compared to base station 1 in FIG.1, memory 41 only comprises all code list 42 and all code list 42 stores code types as well as a count value indicating the frequency of use.

**[0060]** Code determination section 46 incorporates a counter, increments the counter of the code type adopted as the assigned code type of the station and stores the count value in all code list 42. Threshold determination section 45 treats a code type with a higher count value as one with higher priority and sorts all code types in all code list 42 in descending order of priority.

**[0061]** The other components of base station 1 in FIG.11 are the same as those in FIG.1, and so they are assigned the same numbers as those in FIG.1, and their explanations are omitted.

**[0062]** Then, the code assignment operation of the base station in Embodiment 6 is explained using a flow diagram in FIG.12.

**[0063]** When base station 1 determines the code type of the station, the sections of the apparatus are initialized (ST1201), code reading section 44 reads the code type with the highest priority whose interference level has not been measured yet and outputs it to code generation section 31 of interference level measuring section 30 (ST1202) and interference level measuring section 30 measures the level of an interference component of the received signal (ST1203).

**[0064]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST1204) and if the interference level is lower than the threshold, the code type is output to code determination section 46 and code determination section 46 determines the code type as the code type of the station (ST1205) and increments the counter indicating the frequency of use (ST1206).

**[0065]** If the count value reaches a preset upper limit, it subtracts a certain value from the count values of all code types. However, if the count value after the subtraction is a negative value, the count value is set to 0. It is also possible to subtract a certain value only from the count value of the corresponding code type.

**[0066]** Then, threshold determination section 45 treats a code type with a higher count value as one with higher priority and sorts code types in all code list 42 in descending order of priority (ST1207). In ST1204, if the interference level is higher than the threshold, the operations from ST1202 are repeated once again.

**[0067]** Thus, by treating assigned code types with a higher frequency of use as ones with higher priority and measuring the interference level of code types in descending order of priority in code assignment operation, it is possible to efficiently specify code types whose interference level is lower than the threshold and shorten the time required for code assignment operation.

(Embodiment 7)

**[0068]** Embodiment 7 is an embodiment that fixes priority for a first code type group and determines priority based on the interference level measured for a second code type group and preferentially uses codes with higher priority in code assignment operation.

**[0069]** Here, the first code type group is a code type group having the same priority at all base stations and the second code type group is a code group having priority specific to each base station.

**[0070]** FIG.13 is a block diagram showing a configuration of a base station in Embodiment 7. In the base station in FIG.13, compared to base station 1 in FIG.8, all code list 42 stores code types divided into a first code type group and a second code type group and the second code type group is stored together with the interference level of each code type.

**[0071]** Threshold determination section 45 treats code types in the second code type group with a lower interference level as ones with higher priority, and sorts code types in all code list 42 in descending order of priority.

**[0072]** When carrying out code assignment operation, code reading section 44 reads code types of the first code type group in descending order of priority, and then reads code types of the second code type group in descending order of priority.

**[0073]** The other components in base station 1 in FIG.13 are the same as those in FIG.8, and so they are assigned the same numbers as those in FIG.8 and their explanations are omitted.

**[0074]** Then, the code assignment operation of the base station in Embodiment 7 is explained using flow diagrams in FIG.14 and FIG.15.

**[0075]** When base station 1 determines the code type of the station, the sections of the apparatus are initialized (ST1401), code reading section 44 reads the code type in the first code type group with the highest priority whose interference level has not been measured yet and outputs it to code generation section 31 of interference level measuring section 30 (ST1402) and interfer-



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ence level measuring section 30 measures the level of an interference component of the received signal (ST1403).

**[0076]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST1404) and if the interference level is lower than the threshold, the code type is output to code determination section 46 and code determination section 46 determines the code type as the code type of the station (ST1405).

**[0077]** In ST1404, if the interference level is higher than the threshold, the operations from ST1401 are repeated once again and when a search is completed for all code types of the first code type group (ST1406), code reading section 44 reads the code type in the second code type group with the highest priority whose interference level has not been measured yet and outputs it to code generation section 31 of interference level measuring section 30 (ST1407).

**[0078]** Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST1408) and threshold determination section 45 updates the stored interference level to the interference level measured by interference level measuring section 30 (ST1409).

**[0079]** Then, threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST1410) and if the interference level is lower than the threshold, the code type is output to code determination section 46 and code determination section 46 determines the code type as the code type of the station (ST1411).

**[0080]** A code type with a lower interference level is treated as one with higher priority and all code types in the second code type group are sorted in descending order of priority (ST1412). In ST1410, if the interference level is higher than the threshold, the operations from ST1407 are repeated once again.

**[0081]** As seen above, by fixing priority in the first code type group, treating a code type in the second code type group with a higher interference level measured as one with higher priority and measuring the interference level of code types in descending order of priority, it is possible to efficiently specify the code types whose interference level is lower than the threshold and shorten the time required for code assignment operation.

(Embodiment 8)

**[0082]** Embodiment 8 is an embodiment that randomly selects a certain number of code types in code assignment operation, preferentially measures the interference level from the selected codes and uses them as the assigned codes of the station. A base station in Embodiment 8 is the same as the base station shown in FIG.1.

**[0083]** When carrying out code assignment operation, code reading section 44 of base station 1 in Embodiment 8 randomly selects a certain number of code types from all code list 42, reads the selected code types one by one and outputs them to interference level measuring section 30.

**[0084]** Then, the code assignment operation of base station 1 in Embodiment 8 is explained using a flow diagram in FIG.16.

**[0085]** When base station 1 determines the code type of the station, the sections of the apparatus such as candidate code list 43 are initialized (ST1601), code reading section 44 selects a certain number of code types to be searched from all code list 42 (ST1602), reads one code type from among the selected code types and outputs it to code generation section 31 of interference level measuring section 30 (ST1603).

**[0086]** Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST1604) and threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST1605) and if the interference level is lower than the threshold, the corresponding code type as well as the interference level is written to candidate code list 43 (ST1606).

**[0087]** Then, the operations from ST1603 to ST1606 are carried out on all the selected code types (ST1607).

**[0088]** After the operations from ST1603 to ST1606 are carried out on all the selected code types, if there are assignment candidate codes (ST1608), code determination section 46 determines the code type stored in candidate code list 43 with the lowest interference level as the code type of the station (ST1609). In ST1608, if there is no assignment candidate code, a certain number of code types to be searched from among the code types that have not been selected yet and the operations from ST1603 to ST1607 are repeated (ST1602).

**[0089]** Thus, selecting a certain number of code types and assigning codes can shorten the time required for code assignment operation.

**[0090]** By the way, as the method of selecting a certain number of code types, it is also possible to select a code type to be searched first and then select a certain number of code types to be aligned in order starting from this code type. This makes it possible to simplify the circuit to select a certain number of code types.

(Embodiment 9)

**[0091]** Embodiment 9 is a code assignment method by which a radio communication system classifies code types into several groups and assigns one of them to each base station as a preferred group. A base station in Embodiment 9 is the same as the base station shown in FIG.1.



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[0092] When carrying out code assignment operation, code reading section 44 of base station 1 in Embodiment 9 sets a code group to be searched from all code list 42, reads the set code types one by one and outputs them to interference level measuring section 30.

[0093] If the interference level of the code type is not lower than a threshold, threshold determination section 45 deletes all code type data included in the code group to which the code type belongs from candidate code list 43.

[0094] Then, the code assignment operation of base station 1 in Embodiment 9 is explained using a flow diagram in FIG. 17.

[0095] When base station 1 determines the code type of the station, the sections of the apparatus such as candidate code list 43 are initialized (ST1701), code reading section 44 sets a code group to be searched from all code list 42 (ST1702), reads one code type from the selected code group and outputs it to code generation section 31 of interference level measuring section 30 (ST1703).

[0096] Then, interference level measuring section 30 measures the level of an interference component of the received signal (ST1704) and threshold determination section 45 compares the interference level measured by interference level measuring section 30 with a preset threshold (ST1705) and if the interference level is lower than the threshold, the corresponding code type as well as the interference level is written to candidate code list 43 (ST1706).

[0097] Then, the operations from ST1703 to ST1706 are carried out on all the selected code types (ST1707).

[0098] In ST1705, if the interference level exceeds the threshold, all code type data included in the code group to which the code type belongs are deleted from candidate code list 43 (ST1708).

[0099] After the operations from ST1702 to ST1708 are repeated until all code groups are set (ST1709), code determination section 46 determines the code type stored in candidate code list 43 with the lowest interference level as the code type of the station(ST1710).

[0100] At this time, the code group containing the code type determined as the code type of the station is designated as the preferred group of the station.

[0101] Thus, even if a radio communication system adopts a system that classifies code types into several groups and assigns one of them to each base station as the preferred group, it is possible to eliminate the need for additional code assignment design when a new base station is added, for example.

(Embodiment 10)

[0102] Embodiment 10 is a code assignment method when there are a plurality of channels on an assigned frequency axis. FIG. 18 is a block diagram showing a configuration of a base station in Embodiment 10 of the present invention.

[0103] Base station 1 in FIG. 18 mainly comprises transmission/reception section 20 that transmits/receives signals to/from a mobile station and receives an interference signal transmitted from another base station via antenna 10, interference level measuring section 30 that measures the interference level of a signal received by transmission/reception section 20, code assignment control section 40 that carries out code type assignment control based on the interference level, reception level measuring section 50 that measures the reception level of the signal received by transmission/reception section 20 and channel assignment control section 60 that carries out channel assignment control based on the measured reception level.

[0104] Channel assignment control section 60 comprises memory 61 that stores channels and memory 61 comprises all channel list 62 that stores all channels in a list form and candidate channel list 63 that stores assignment candidate channels in a list form. Channel assignment control section 60 also comprises channel setting section 64 that sets channels to be measured from all channel list 62 and outputs them to reception level measuring section 50, threshold determination section 65 that determines assignment candidate channels from the reception level input from reception level measuring section 50 and a preset threshold and writes the channel number to be an assignment candidate to candidate channel list 63 and channel determination section 66 that determines the channel of the station used from candidate channel list 63 and outputs it to code assignment control section 40.

[0105] Interference level measuring section 30 and code assignment control section 40 adopts one of Embodiment 1 to Embodiment 9.

[0106] Then, the channel assignment operation of base station 1 in Embodiment 10 is explained using a flow diagram in FIG. 19.

[0107] When base station 1 determines the channel of the station, the sections of the apparatus such as candidate channel list 63 are initialized (ST1901), channel setting section 64 reads one channel to be searched from all channel list 62 and outputs it to reception level measuring section 50 (ST1902) and reception level measuring section 50 measures the reception level of the received signal (ST1903).

[0108] Then, threshold determination section 65 compares the reception level measured by reception level measuring section 50 with a preset threshold (ST1904) and if the reception level is lower than the threshold, the corresponding channel number is written to candidate channel list 63 (ST1905).

[0109] Then, the operations from ST1902 to ST1905 are carried out on all channels stored in all channel list 62 (ST1906) and channel determination section 66 determines the channel of the station from among channels stored in the candidate channel list (ST1907).

[0110] After the channel assignment operation is com-



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pleted, through the determined channel of the station, interference level measuring section 30 and code assignment control section 40 carry out the code assignment operation explained in one of Embodiment 1 to Embodiment 9 and determine the code type of the station.

**[0111]** As seen above, measuring the reception level for each channel, determining the channel of the station and carrying out code assignment operation through the determined channel of the station eliminates the need for theoretical design for assigning codes to all base stations even if there are a plurality of channels on the assigned frequency axis.

**[0112]** As the method of determining the channel of the station, it is also possible to store channels as well as the reception levels in the candidate channel list and determine the one with the lowest reception level as the channel of the station. This allows communications using the channel with the best communication quality.

**[0113]** Furthermore, as the method of determining the channel of the station, it is also possible to store channels as well the reception levels in the candidate channel list and determine the one with the highest reception level as the channel of the station. This makes it possible to improve the efficiency in repeatedly using the same channel and efficiently arrange base stations.

**[0114]** The embodiments above explained cases where a code type was used as code specification information, but the present invention is not limited to this, and can use other information such as code phase. Furthermore, the embodiments above can be combined among them as appropriate.

**[0115]** In the embodiments above, the frequency of implementing code assignment operation can be set as appropriate such as implementing code assignment operation at specific intervals or when power is turned on.

**[0116]** The base station apparatus in the embodiments above can switch code types when the communication quality deteriorates by the mobile station apparatus monitoring the communication quality and reporting it to the base station apparatus and the base station apparatus carrying out code assignment operation based on the communication quality related information from the mobile station apparatus.

**[0117]** An explanation for this code type switching method is given below. FIG.20 is a system diagram showing a radio communication system including the CDMA base station apparatus of the present invention. Mobile station apparatus 2 and mobile station apparatus 3 in FIG.20 are located in a radio zone which is an area allowing communications with base station apparatus 1 and have a function to monitor the communication quality and report it to the base station apparatus.

**[0118]** Now, suppose base station apparatus 1 transmits a signal to mobile station apparatus 2 and mobile station apparatus 3 using code type n and the transmission/reception section determines whether the communication quality has deteriorated or not based on the communication quality related information received from mobile station apparatus 2 and mobile station apparatus 3.

**[0119]** If base station apparatus 1 determines that the communication quality has deteriorated, it first determines code type m to be updated using the code assignment method explained in one of the embodiments above.

**[0120]** Then, base station apparatus 1 notifies mobile station apparatus 2 and mobile station apparatus 3 of the time required until the code is changed. When the notified time has elapsed, base station apparatus 1 switches code type n to code type m.

**[0121]** Thus, switching a code type when the communication quality deteriorates can maintain the communication quality optimal even if interference from neighboring cells occurs.

**[0122]** Furthermore, when there are a plurality of code types to be searched, it is possible to share code types to be searched between the base station and mobile station, search respective shared code types, report the search results from the mobile station to the base station, organize the search results by the base station and switch the code types based on these search results.

**[0123]** If the mobile station can perform RAKE reception with a plurality of code types, it is also possible, when switching code types, for the base station to transmit a signal using both code types before and after the update and for the mobile station to perform RAKE reception of both code types before and after the update.

**[0124]** In the case of a radio communication system that performs transmission from the base station to mobile station using a plurality of code types, it is normally possible to determine all code types used using the code assignment method explained in one of the embodiments above. When switching the code type whose communication quality has deteriorated in this radio communication system, if nothing other than the code to be switched is changed, it is possible to carry out smooth switching of code types without deteriorating the overall communication quality.

**[0125]** As explained above, the CDMA base station apparatus and code assignment method of the present invention can eliminate the need for theoretical design for assigning codes to all base stations even if a new base station is added.

**[0126]** The present invention is not limited to the above described embodiments, and various variations and modifications may be possible without departing from the scope of the present invention.

**[0127]** This application is based on the Japanese Patent Application No.HEI 10-269608 filed on September 24, 1998, entire content of which is expressly incorporated by reference herein.



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## Claims

1. A CDMA base station apparatus, comprising:

   interference level measuring means (30) for measuring the interference level of a signal with respect to code specification information; and
   code assignment control means (40) for assigning code specification information of said station based on the interference level measured by this interference level measuring means.

2. The CDMA base station apparatus according to claim 1,
   wherein the interference level measuring means comprises:

   code generation means (31) for generating codes based on the code specification information;
   despreading means (32) for despreading the received signal multiplied by a code generated by said code generation means; and
   level calculation means (33) for calculating the interference level from the despread signal.

3. The CDMA base station apparatus according to claim 1,
   wherein code assignment control means comprises:

   code reading means (44) for reading the stored code specification information and outputting it to the interference level measuring means;
   threshold determination means (45) for selecting the code specification information whose interference level is smaller than a preset threshold as a code information candidate of said station; and
   code determination means (46) for determining the code specification information of said station from the code specification information selected by this threshold determination means.

4. The CDMA base station apparatus according to claim 3,
   wherein the code determination means uses the selected code specification information with the lowest interference level as the code specification information of said station.

5. The CDMA base station apparatus according to claim 3,
   wherein the code determination means uses the selected code specification information with the highest interference level as the code specification information of said station.

6. The CDMA base station apparatus according to claim 3,
   wherein the code reading means reads the previous code specification information of said station;

   the threshold determination means outputs the previous code specification information of said station to the code determination means if the interference level of the previous code specification information of said station is smaller than the preset threshold; and
   if the code determination means inputs the previous code specification information of said station, it uses this information as the code specification information of said station.

7. The CDMA base station apparatus according to claim 3,
   wherein the threshold determination means counts the number of times the interference level of each code specification information piece was smaller than a preset threshold; and

   the code reading means reads code specification information pieces in descending order of said number of times counted.

8. The CDMA base station apparatus according to claim 7,
   wherein the code reading means reads the code specification information of said station during a communication;

   the interference level measuring means measures the interference level of the code specification information of said station; and
   the threshold determination means compares the interference level of the code specification information of said station with a preset threshold and counts the number of times the interference level was smaller than the preset threshold.

9. The CDMA base station apparatus according to claim 3,
   wherein the threshold determination means stores the interference level of each code specification information piece; and

   the code reading means reads code specification information pieces in ascending order of said stored interference level.

10. The CDMA base station apparatus according to claim 9,



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wherein the code reading means reads the code specification information of said station during a communication;

the interference level measuring means measures the interference level of the code specification information of said station; and
the threshold determination means compares the interference level of the code specification information of said station with a preset threshold and updates the stored interference level.

11. The CDMA base station apparatus according to claim 9, comprising:

a first code specification information group that contains code specification information with fixed reading order; and
a second code specification information group that contains code specification information without fixed reading order,
wherein the code reading means, when reading code specification information from the second code specification information group, reads code specification information in ascending order of the stored interference level.

12. The CDMA base station apparatus according to claim 3,
wherein the code determination means counts the number of times each code specification information piece was set as the code specification information of said station; and

the code reading means reads code specification information pieces in descending order of the number of times each code specification information piece was set as the code specification information of said station.

13. The CDMA base station apparatus according to claim 1, comprising:

a plurality of code specification information groups containing code specification information,
wherein if there is code specification information included in one of the code specification information groups whose interference level is smaller than a preset threshold, the code assignment control means determines the code information of said station without measuring the interference level of the code specification information other than said code specification information.

14. The CDMA base station apparatus according to claim 13, which forms code specification information groups by dividing a certain number of code specification information into pieces in order of arrangement.

15. The CDMA base station apparatus according to claim 13,
wherein the threshold determination means does not select a code information candidate of said station from among code specification information groups containing code specification information whose interference level is greater than a preset threshold.

16. The CDMA base station apparatus according to claim 1, comprising:

reception level measuring means for measuring the reception level of the received signal; and
channel assignment control means for assigning the channel of said station based on the reception level measured by this reception level measuring means,
wherein the channel of said station assigns the code specification information of said station.

17. The CDMA base station apparatus according to claim 16,
wherein the channel assignment control means comprises:

channel setting means for reading a stored channel number and outputting it to the reception level measuring means;
threshold determination means for selecting a channel number whose reception level is smaller than a preset threshold as a channel number candidate of said station; and
channel determination means for determining the channel of said station from the channel numbers selected by this threshold determination means.

18. The CDMA base station apparatus according to claim 17,
wherein the channel determination means uses one of the selected channels with the lowest reception level as the channel of said station.

19. The CDMA base station apparatus according to claim 17,
wherein the channel determination means uses one of the selected channels with the highest reception level as the channel of said station.

20. A CDMA mobile station apparatus, which carries out radio communications with the CDMA base station apparatus according to claim 1.



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21. The CDMA mobile station apparatus according to claim 20, which monitors the communication quality and transmits information on the communication quality to the CDMA base station apparatus.

22. A code assignment method, which measures the interference level of a signal to code specification information and assigns the code specification information of said station based on this measured interference level.

23. The code assignment method according to claim 22, which measures the interference level of the signal to the code specification information by despreading the received signal multiplied by a code generated based on the code specification information and calculating the interference level from the despread signal.

24. The code assignment method according to claim 22, which reads the stored code specification information, measures the interference level of the signal to the code specification information, selects the code specification information whose interference level is smaller than the preset threshold as a code information candidate of said station and determines the code specification information of said station from the selected code specification information.

25. The code assignment method according to claim 24, which uses the selected code specification information with the lowest interference level as the code specification information of said station.

26. The code assignment method according to claim 24, which uses the selected code specification information with the highest interference level as the code specification information of said station.

27. The code assignment method according to claim 24, which reads the previous code specification information of said station and if the interference level of this code specification information is smaller than a preset threshold, uses the previous code specification information of said station as the code specification information of said station.

28. The code assignment method according to claim 24, which counts the number of times the interference level of each code specification information piece was smaller than a preset threshold and reads code specification information pieces in descending order of the number of times counted.

29. The code assignment method according to claim 28, which reads the code specification information of said station during a communication, measures the interference level, compares the interference level of the code specification information of said station with a preset threshold, and counts the number of times the interference level of each code specification information piece was smaller than the preset threshold.

30. The code assignment method according to claim 24, which stores the interference level of each code specification information piece and reads code specification information pieces in ascending order of the stored interference level.

31. The code assignment method according to claim 30, which reads the code specification information of said station during a communication, measures the interference level, compares the interference level of the code specification information of said station with a preset threshold, and updates the stored interference level.

32. The code assignment method according to claim 30, which reads code specification information pieces in ascending order of the stored interference level when reading code specification information from a code specification information group containing code specification information whose reading order is not fixed.

33. The code assignment method according to claim 24, which counts the number of times each code specification information piece is set as the code specification information of said station and reads code specification information pieces in descending order of this number of times.

34. The code assignment method according to claim 22, which if there is code specification information included in one of a plurality of code specification information group whose interference level is smaller than the preset threshold, determines the code specification information of said station without measuring the interference level for code specification information other than said code specification information group.

35. The code assignment method according to claim 34, which divides code specification information into a certain number of pieces in order of arrangement and forms code specification information groups.

36. The code assignment method according to claim 34, which does not select a code information candidate of said station from a code specification information group containing code specification information whose interference level is greater than a preset threshold.



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37. The code assignment method according to claim 22, which measures the reception level of the received signal, assigns the channel of said station and assigns the code specification information of said station on the channel of said station.

38. A code switching method, wherein the mobile station apparatus side monitors the communication quality and reports it to the base station apparatus, and if the base station apparatus determines from said report that the communication quality has deteriorated, it newly determines the code information of said station using the code assignment method according to claim 22 and carries out communications using the determined code information.

39. The code switching method according to claim 38, wherein the base station apparatus performs transmission during hand-off using said station code information currently in use as well as newly determined local station code information and the mobile station apparatus performs RAKE reception.

40. The code switching method according to claim 39, wherein the base station apparatus performs transmission to the mobile station apparatus using a plurality of code information pieces of said station and continues to use the code information pieces of said station except those whose communication quality is considered as having deteriorated during hand-off.



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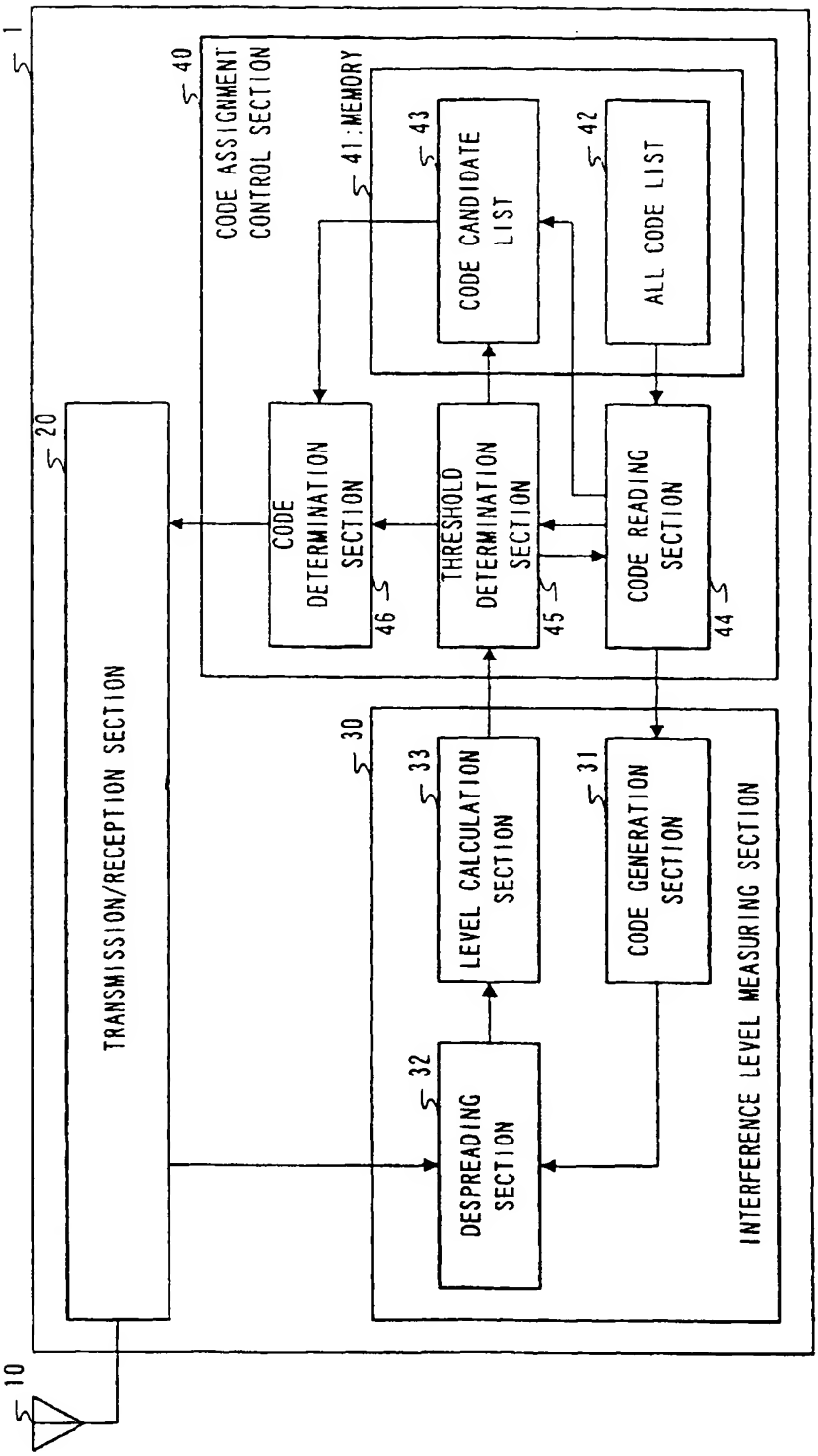


FIG. 1



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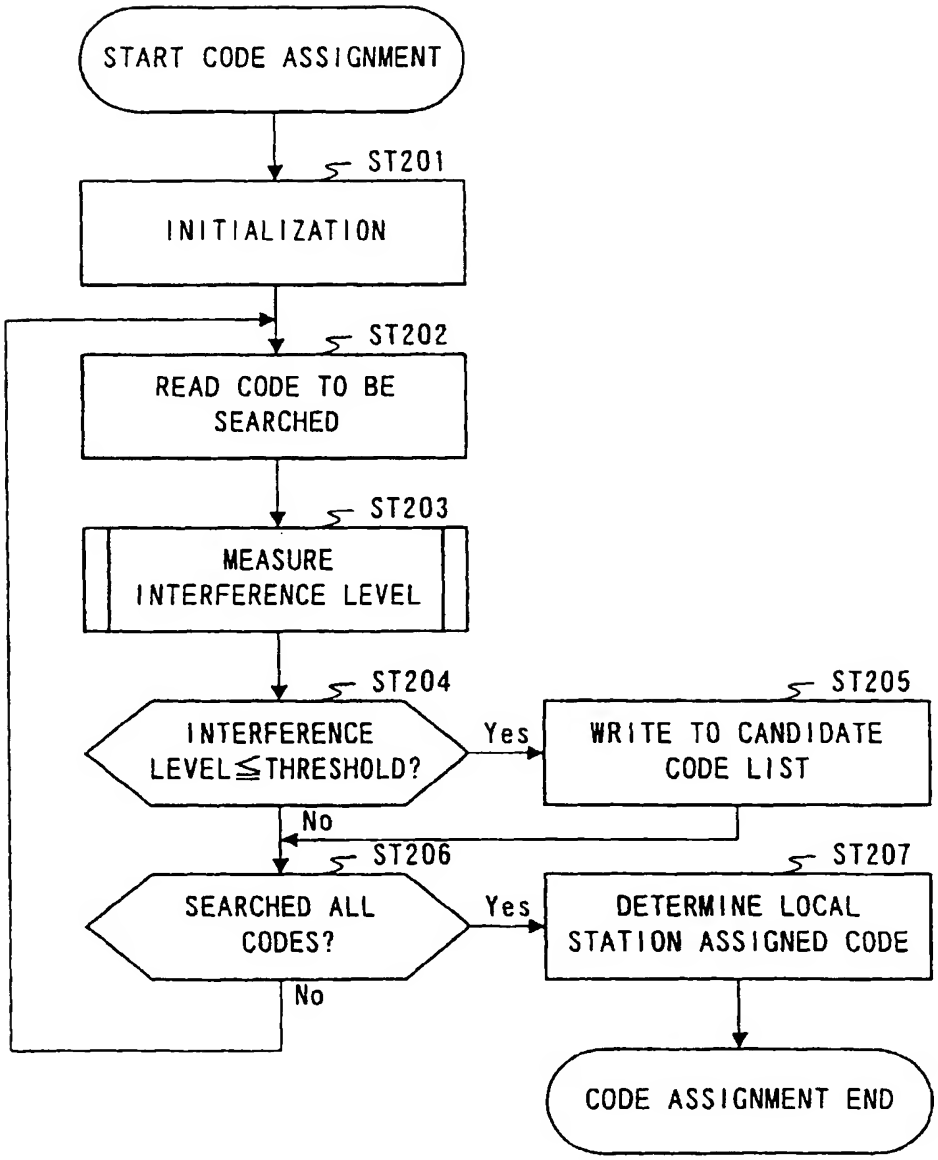


FIG. 2



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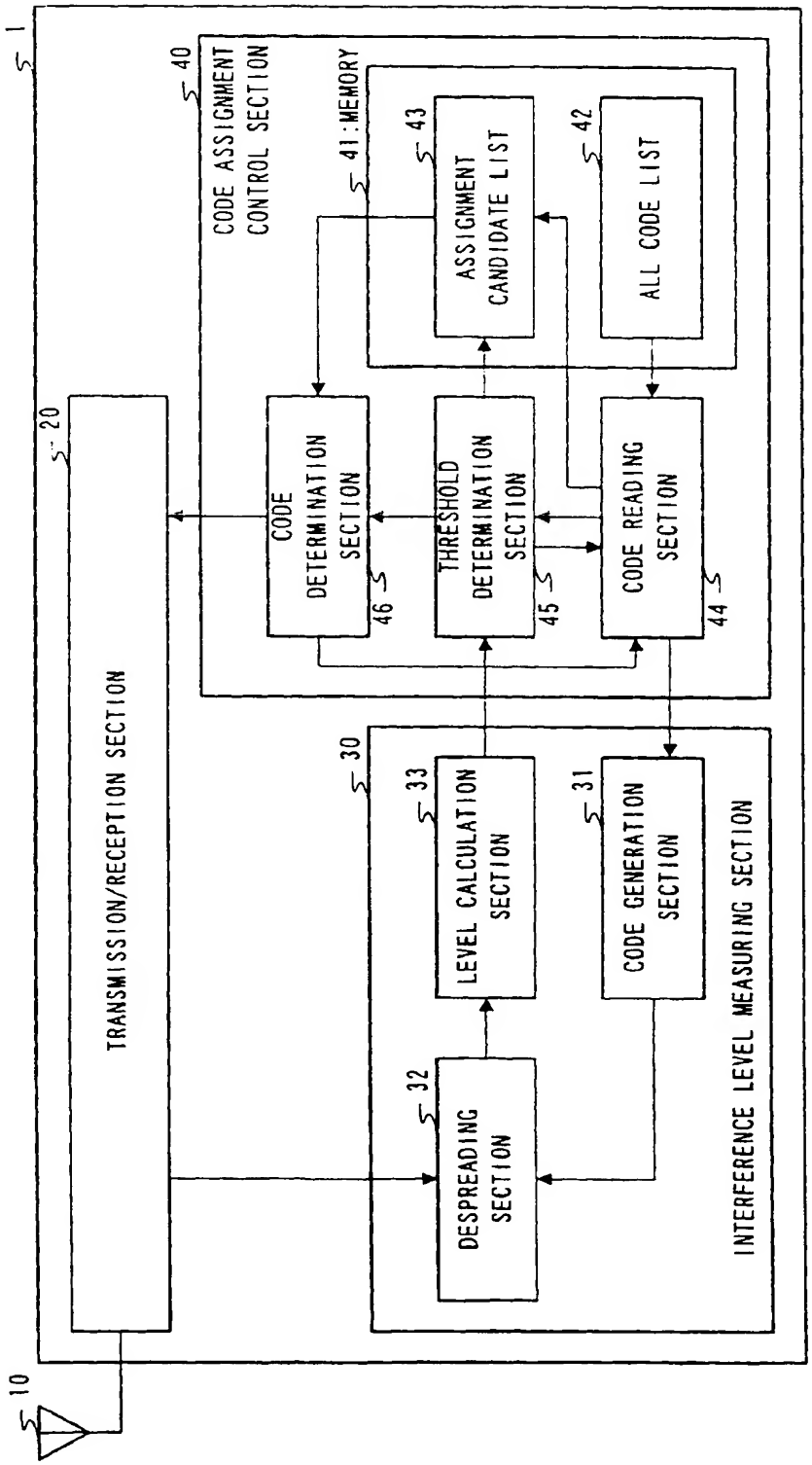


FIG. 3



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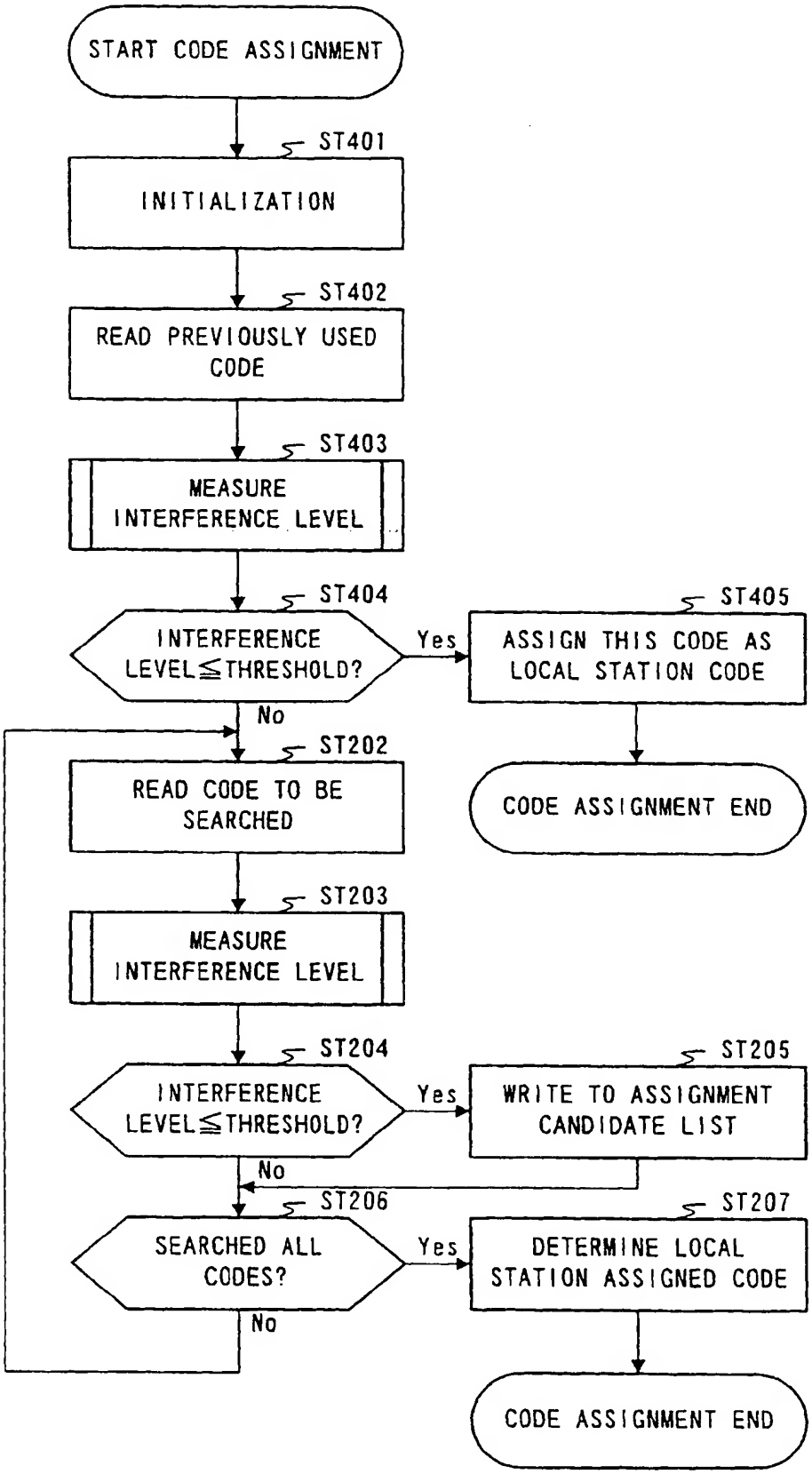


FIG. 4



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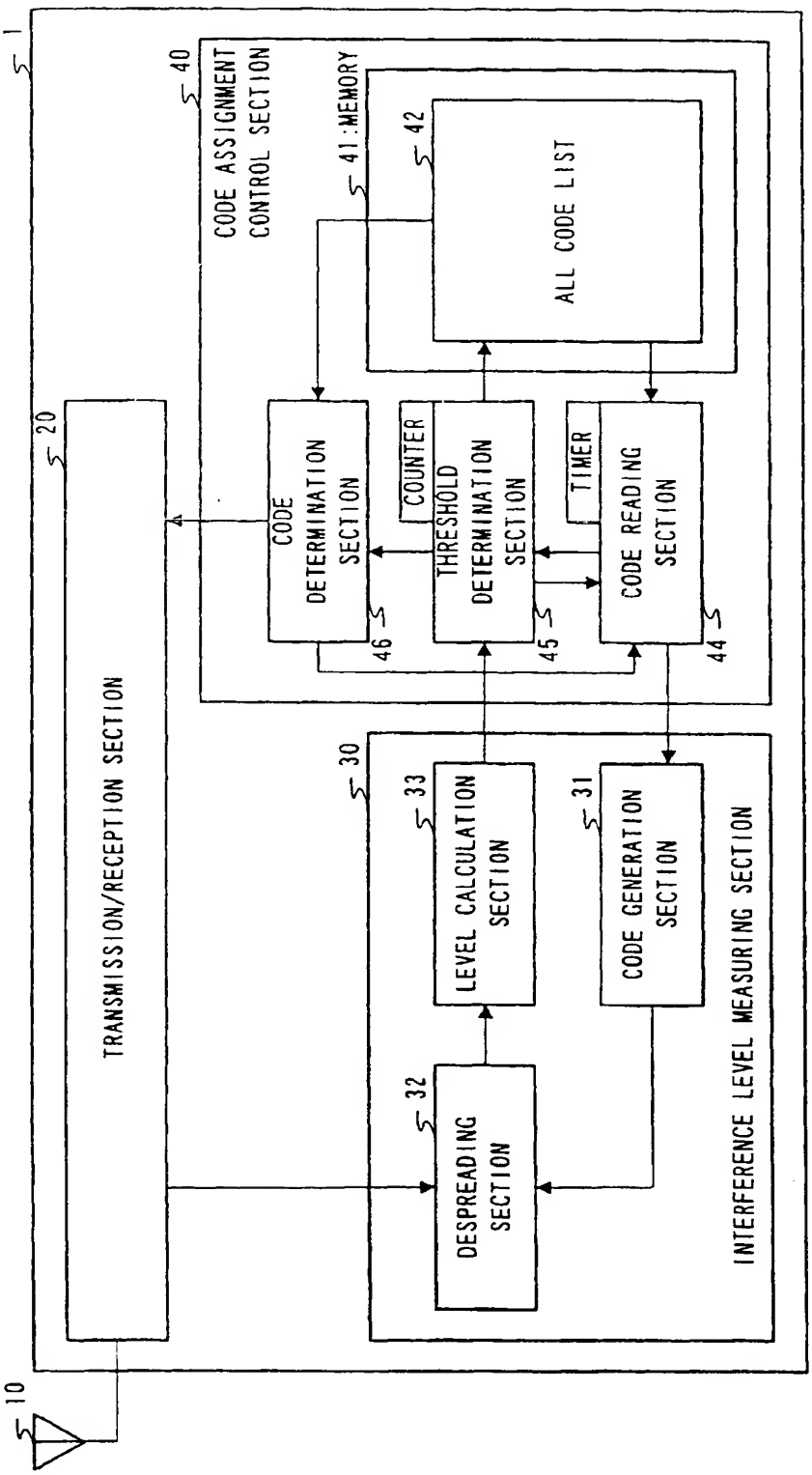


FIG. 5



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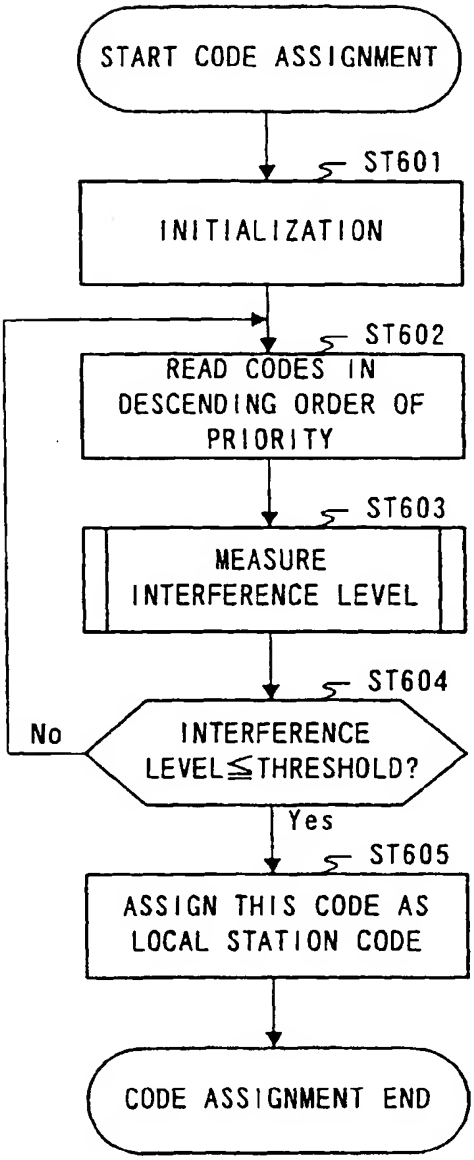


FIG. 6



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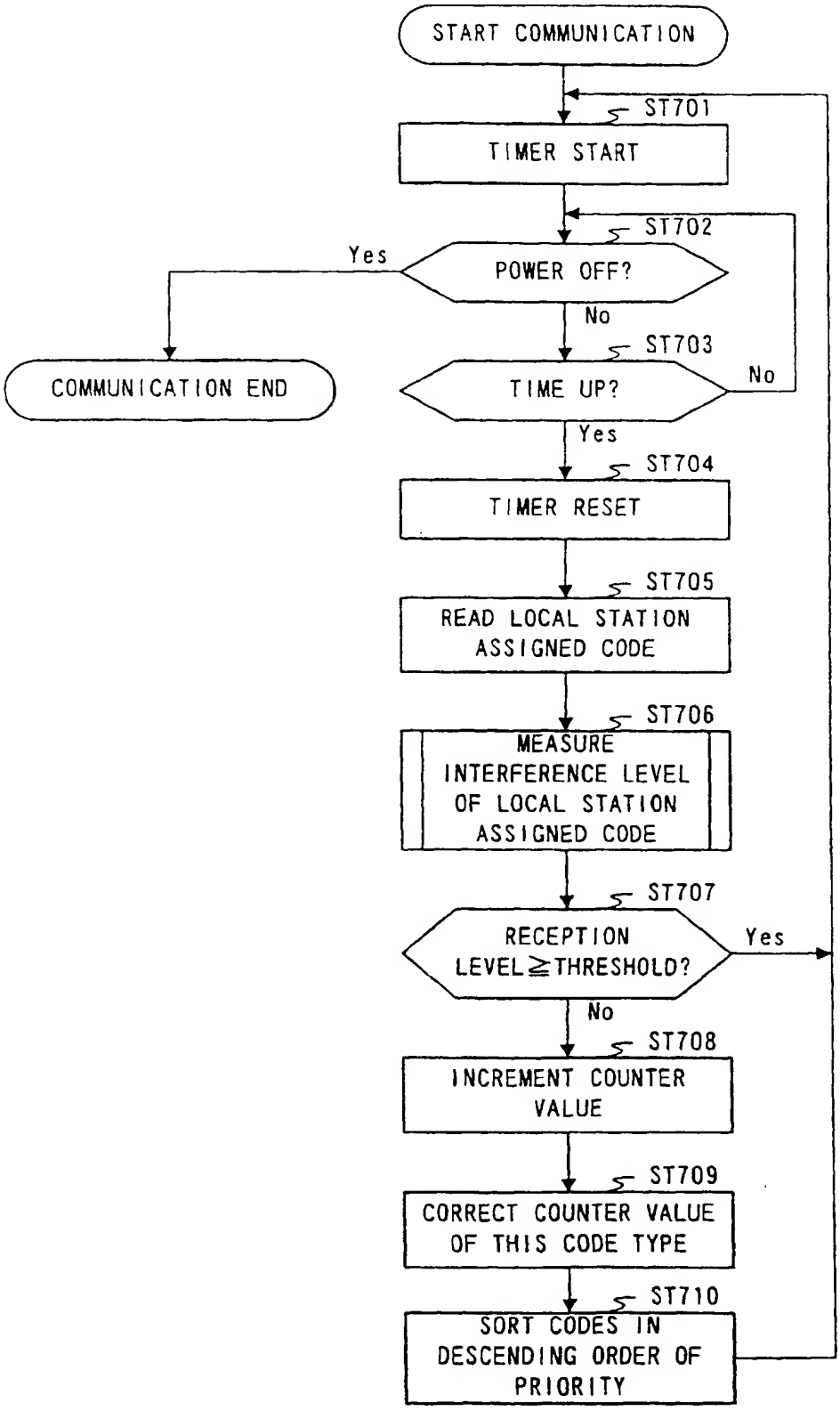


FIG. 7



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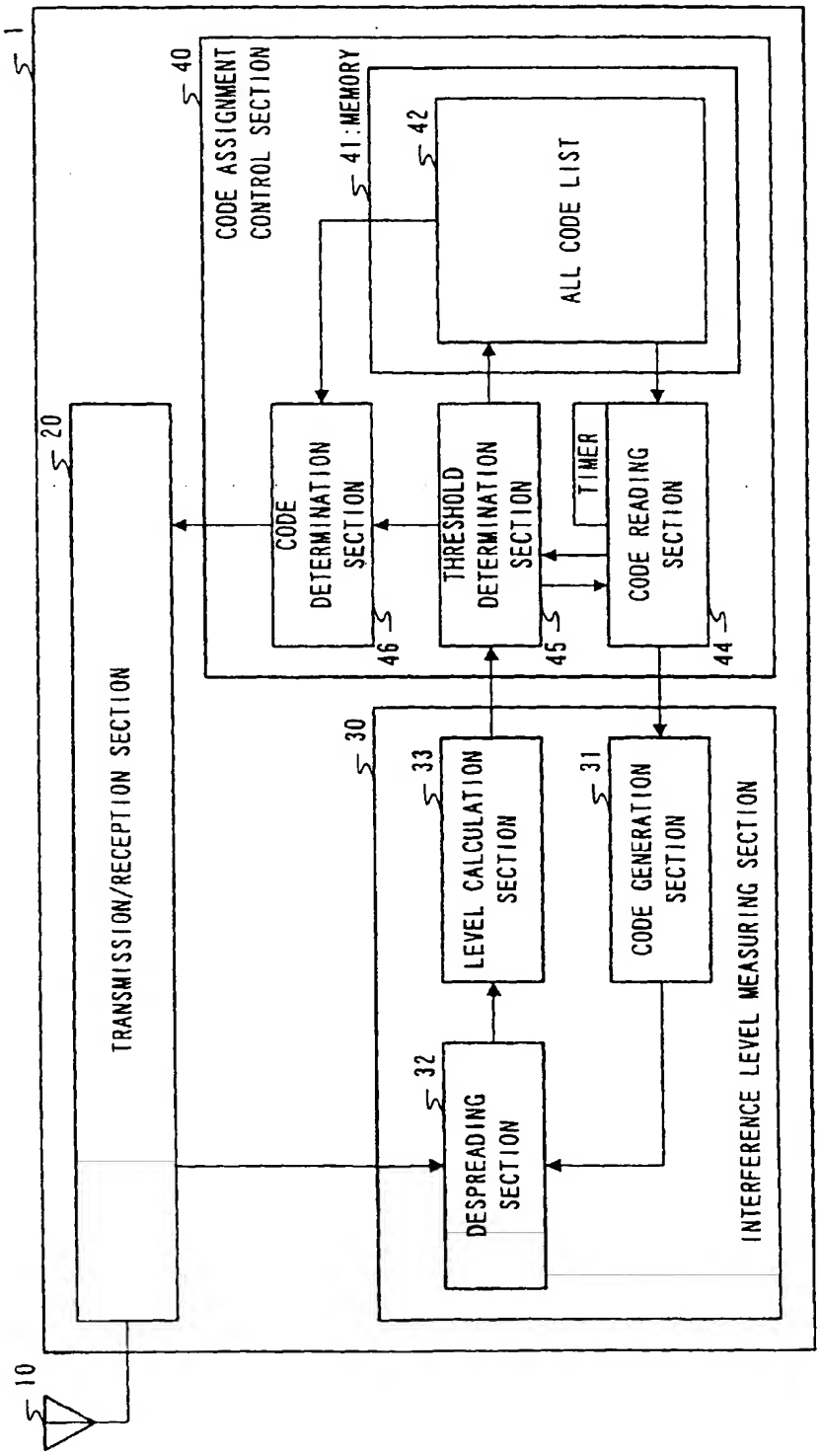


FIG. 8



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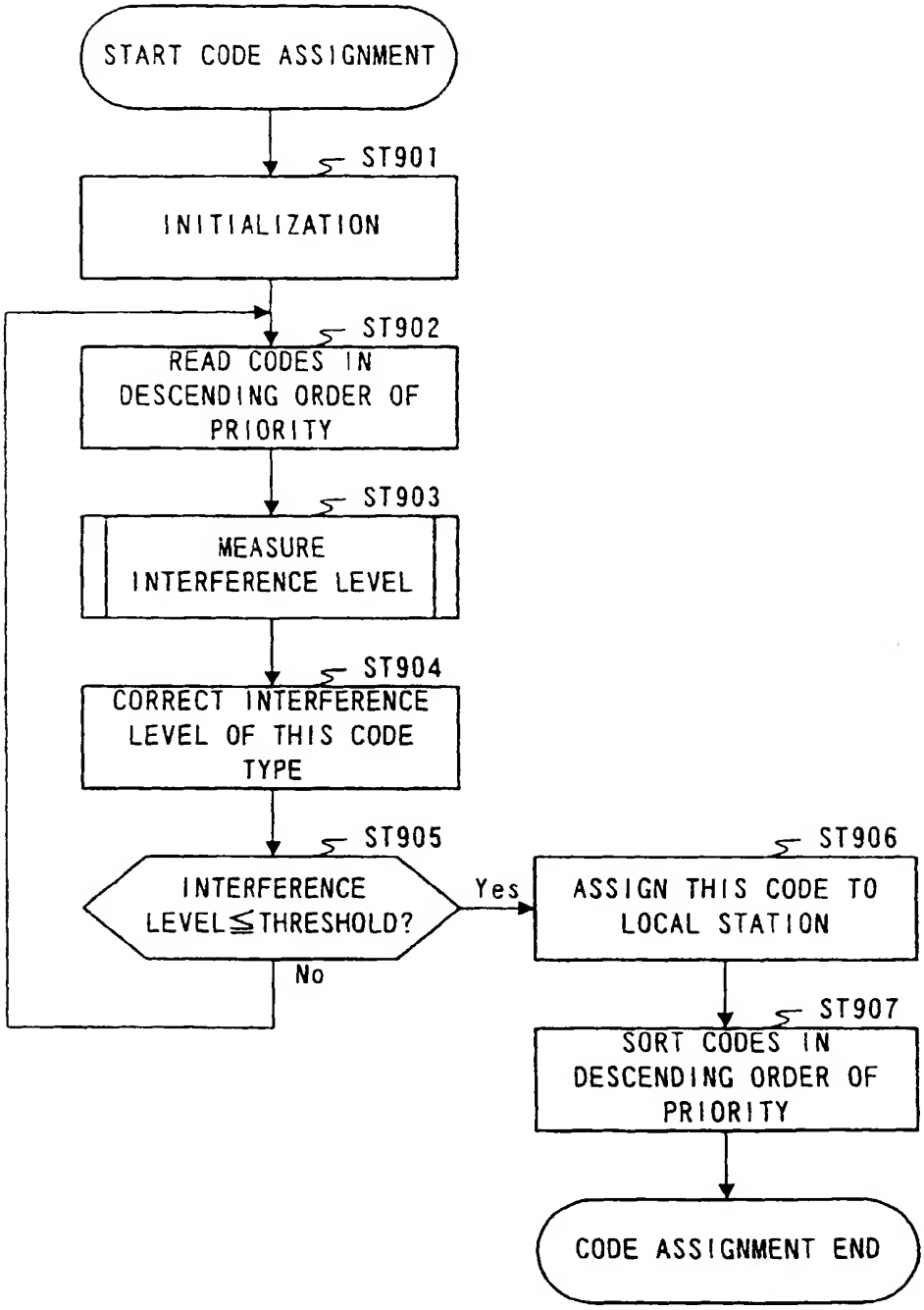


FIG. 9



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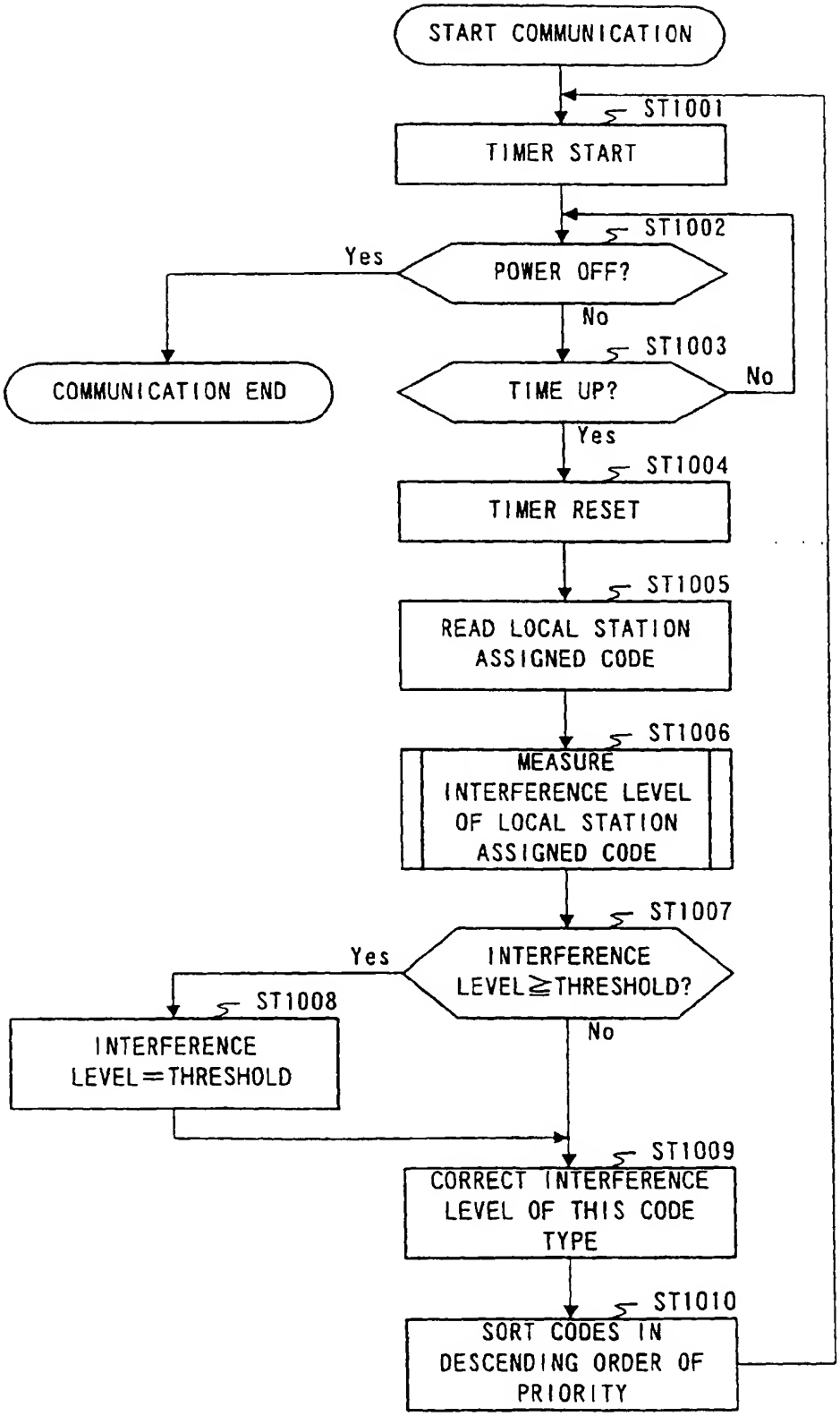


FIG. 10



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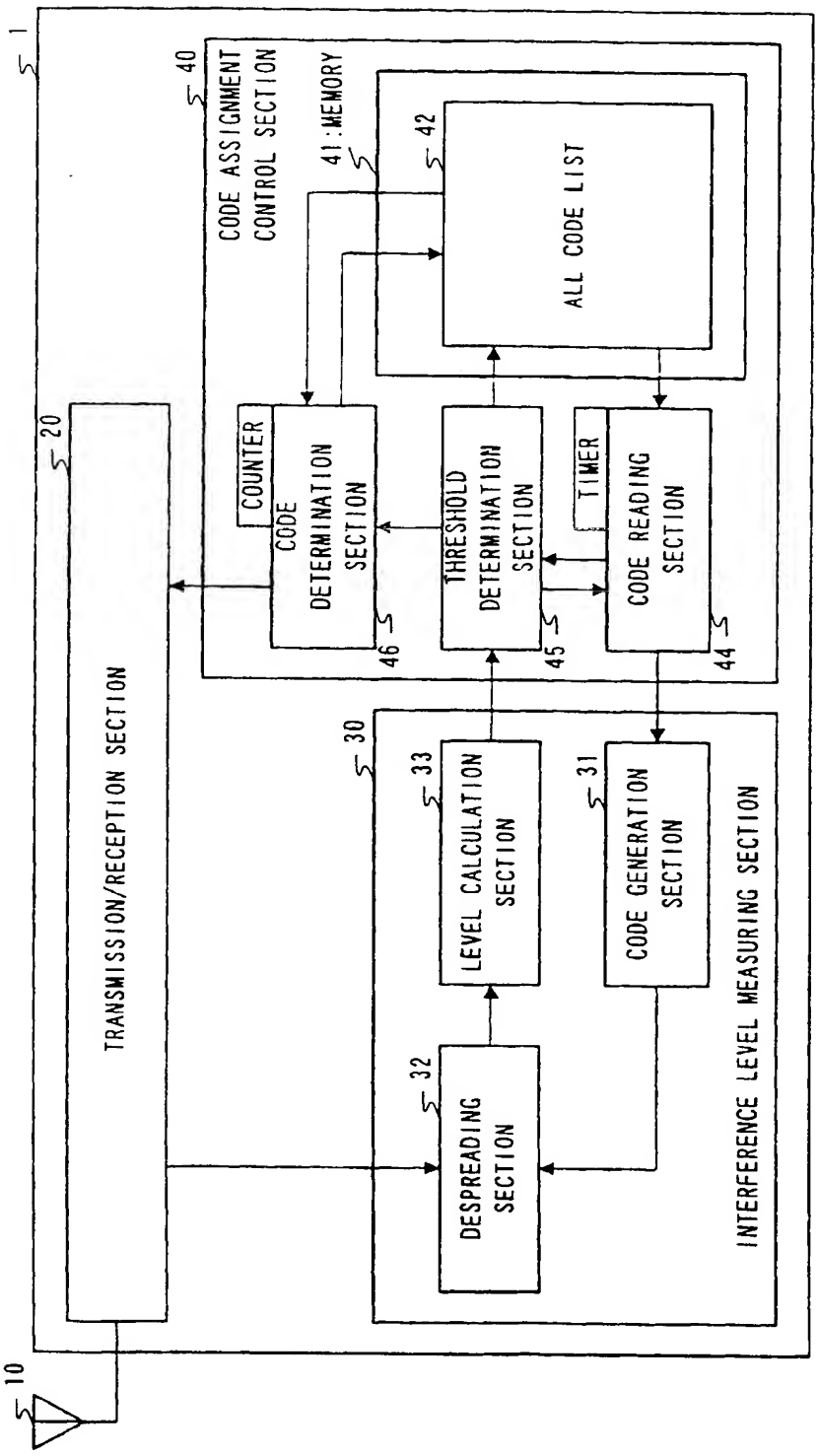


FIG. 11



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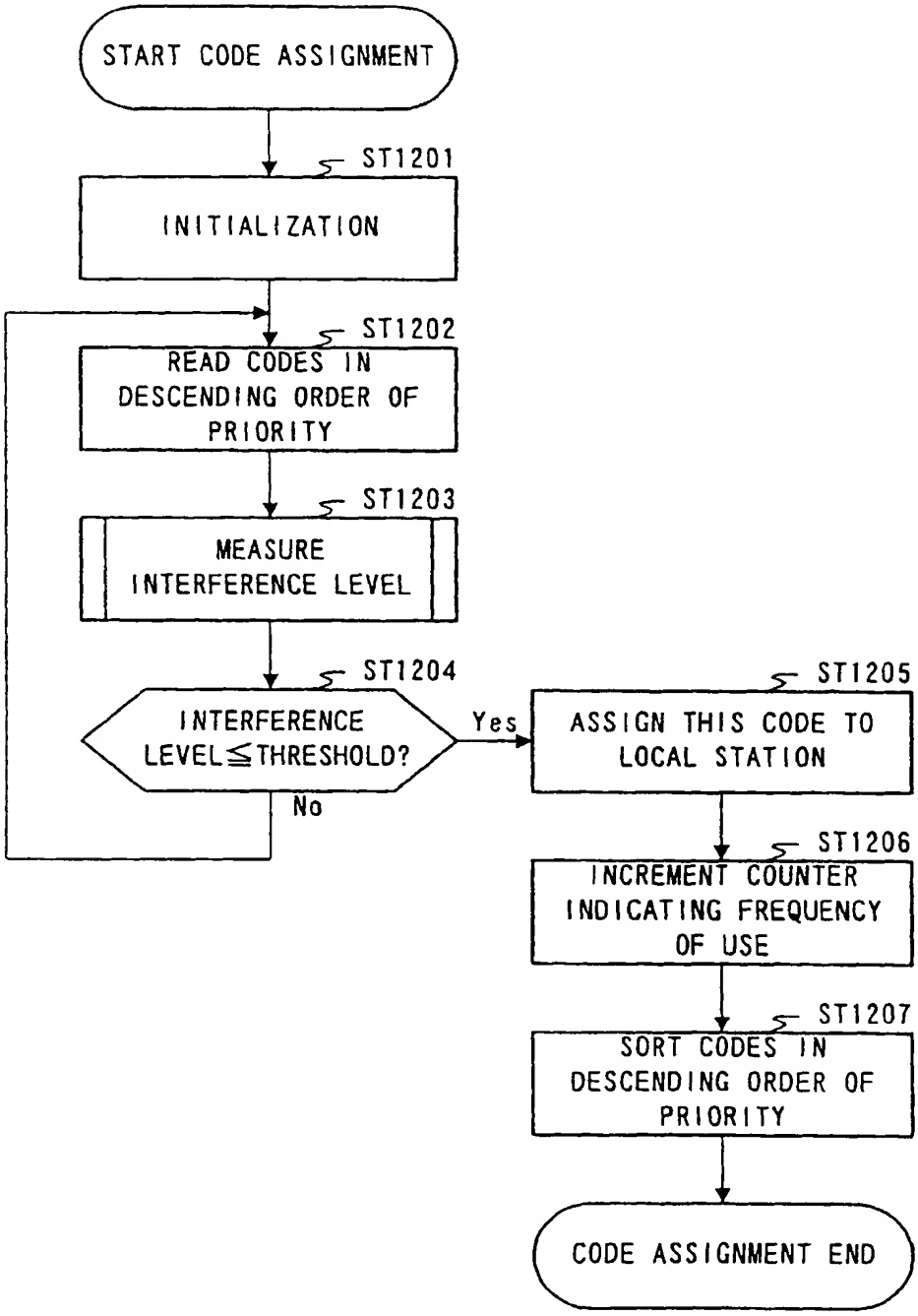


FIG. 12



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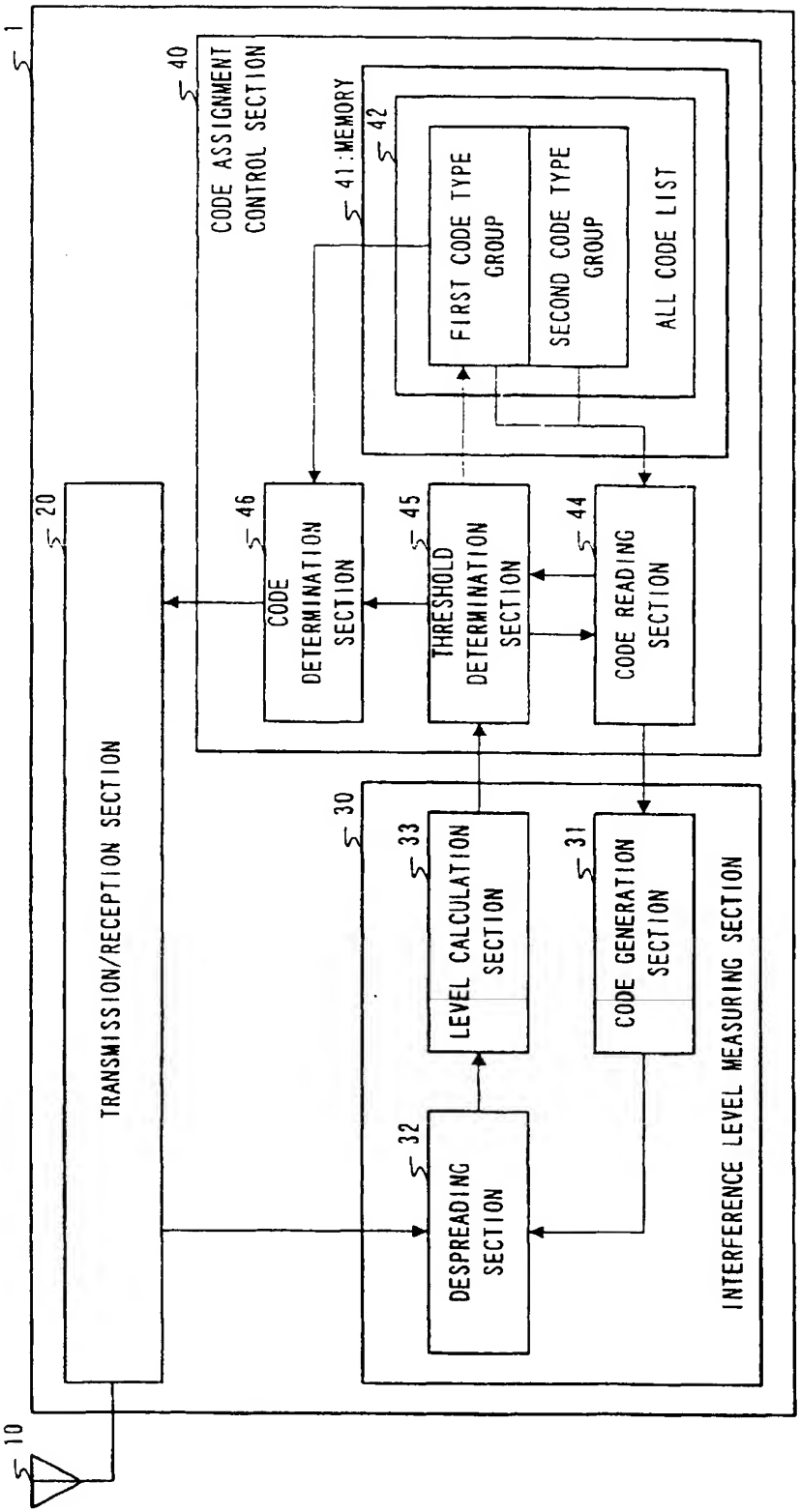


FIG. 13



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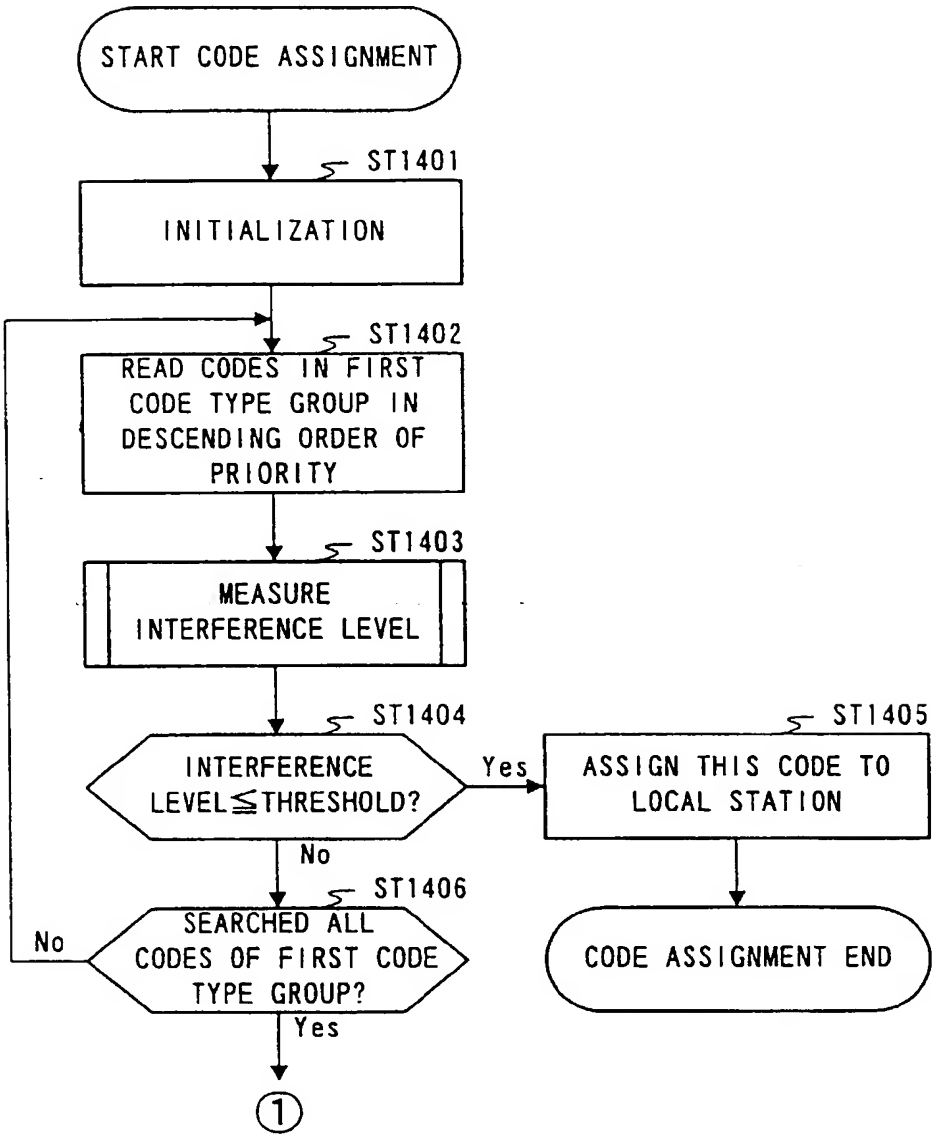


FIG. 14



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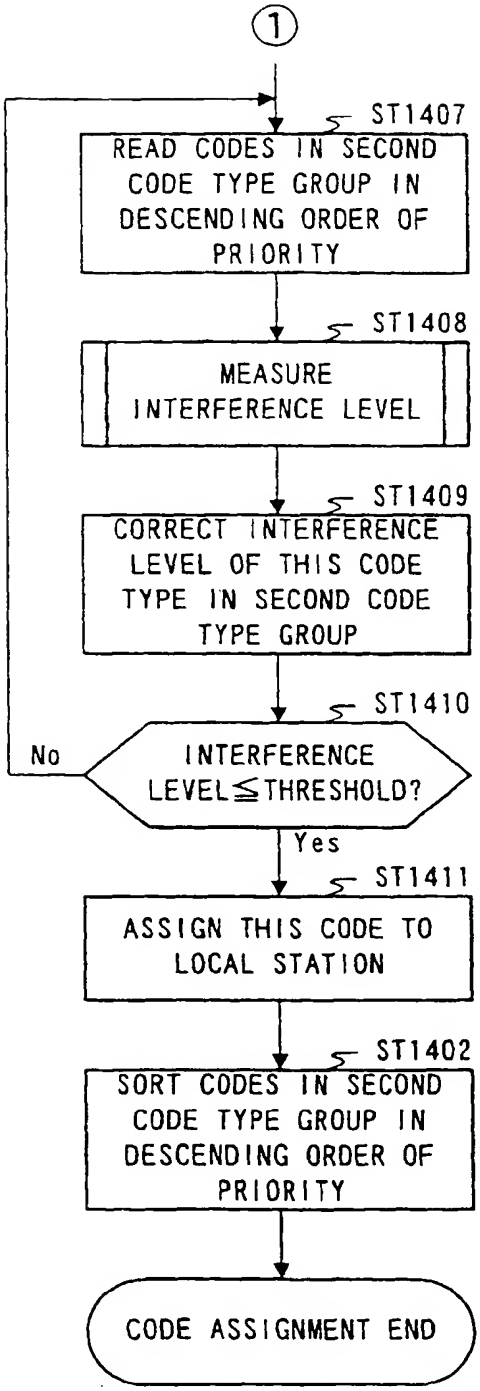


FIG. 15



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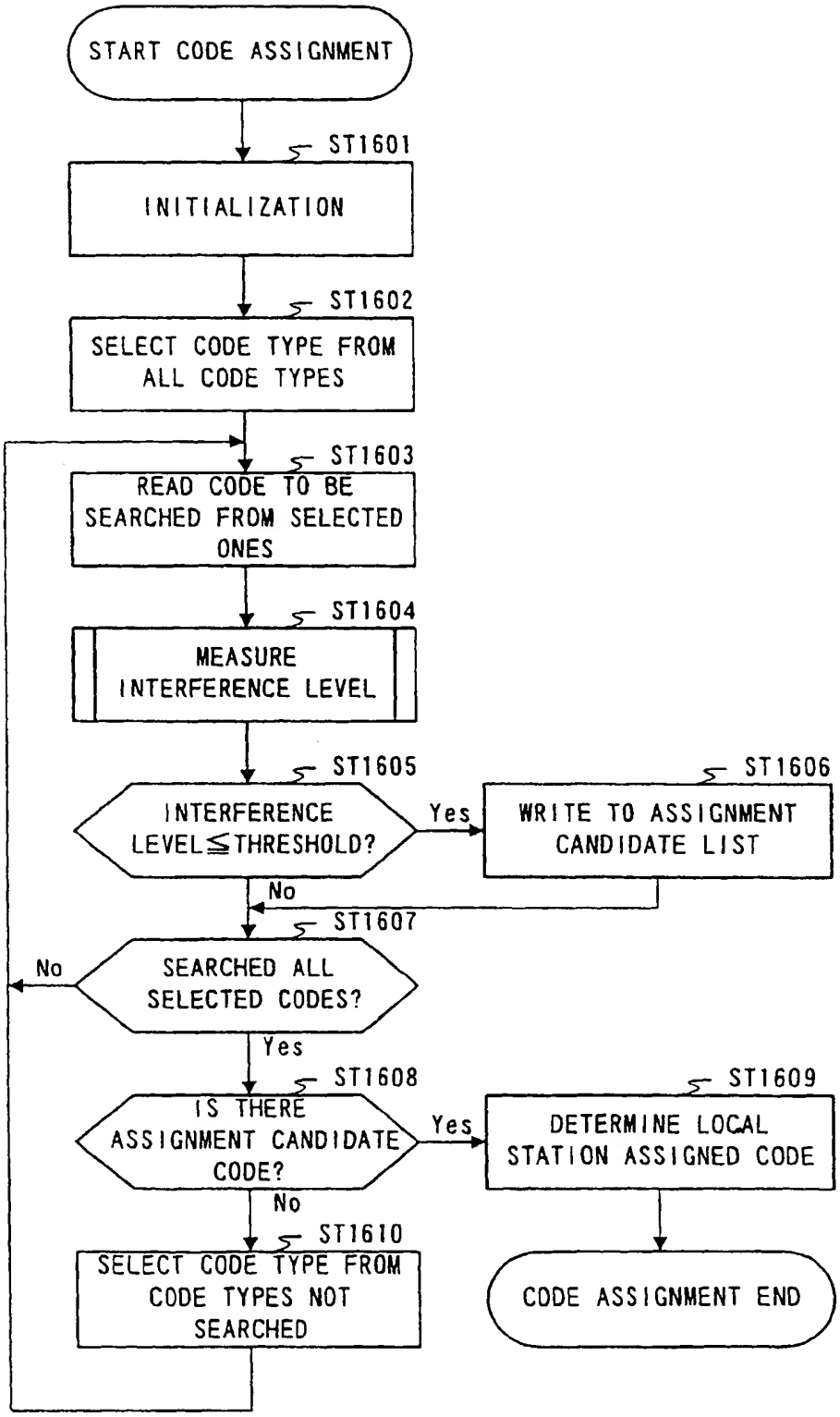


FIG. 16



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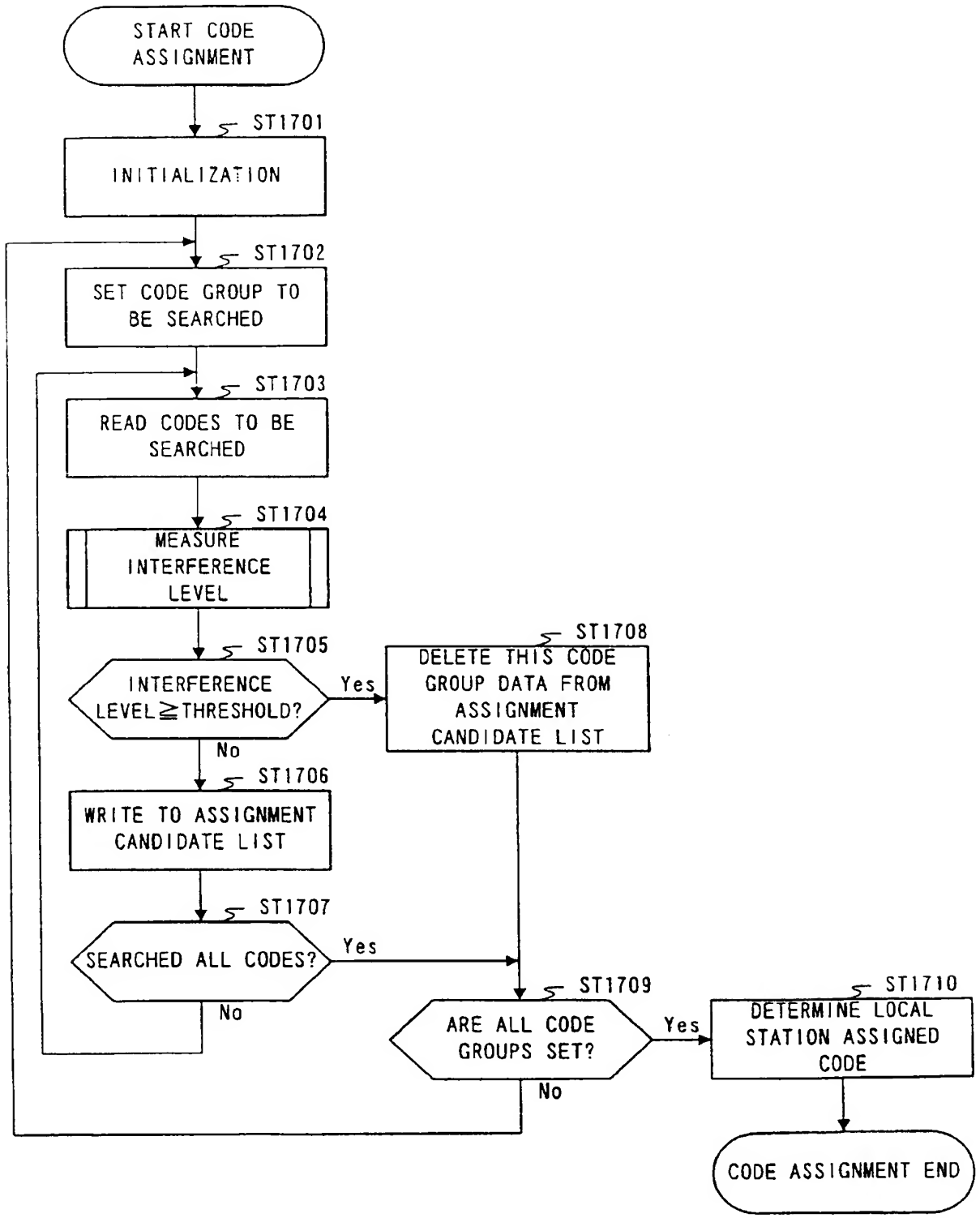


FIG. 17



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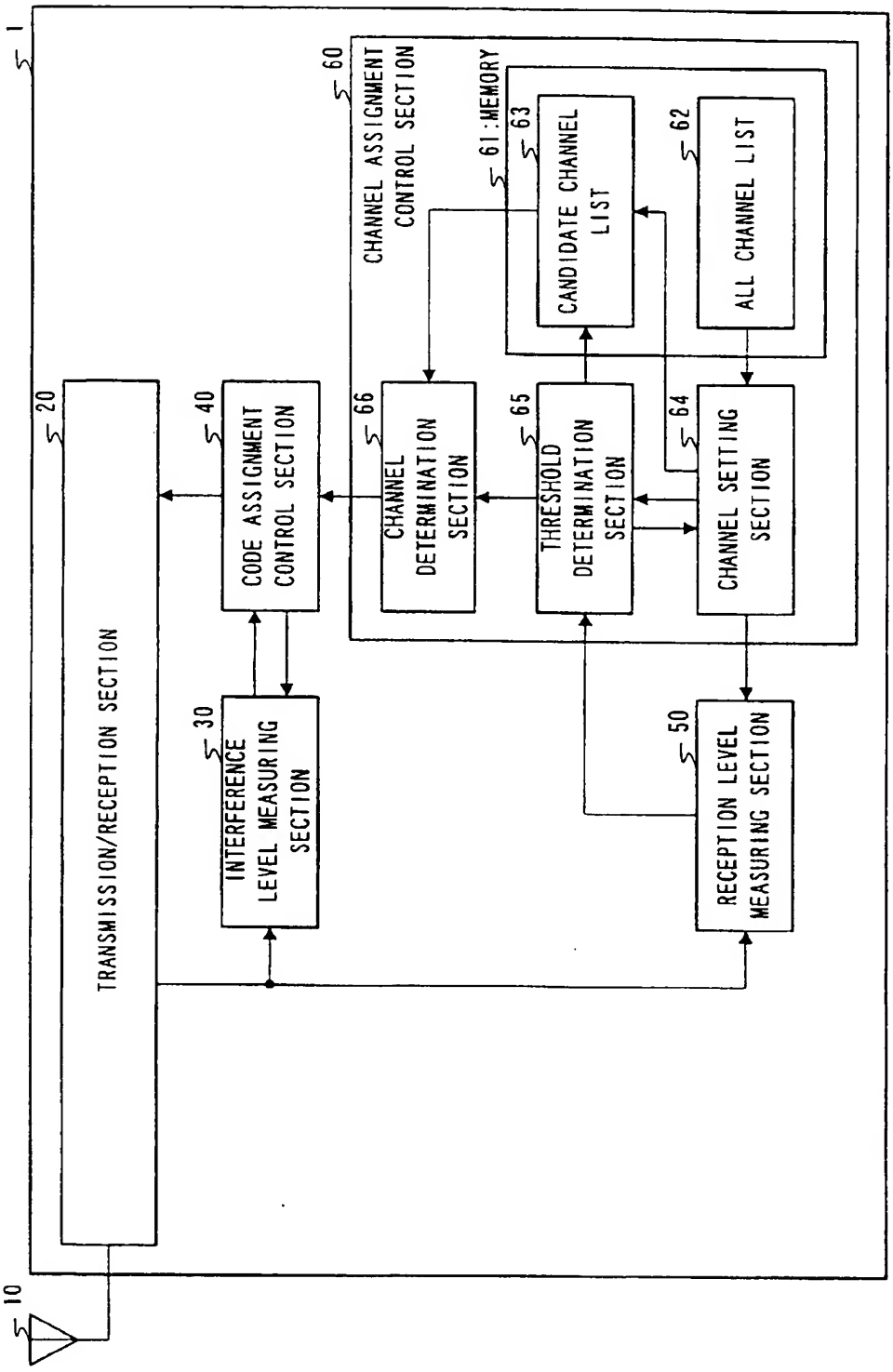


FIG. 18



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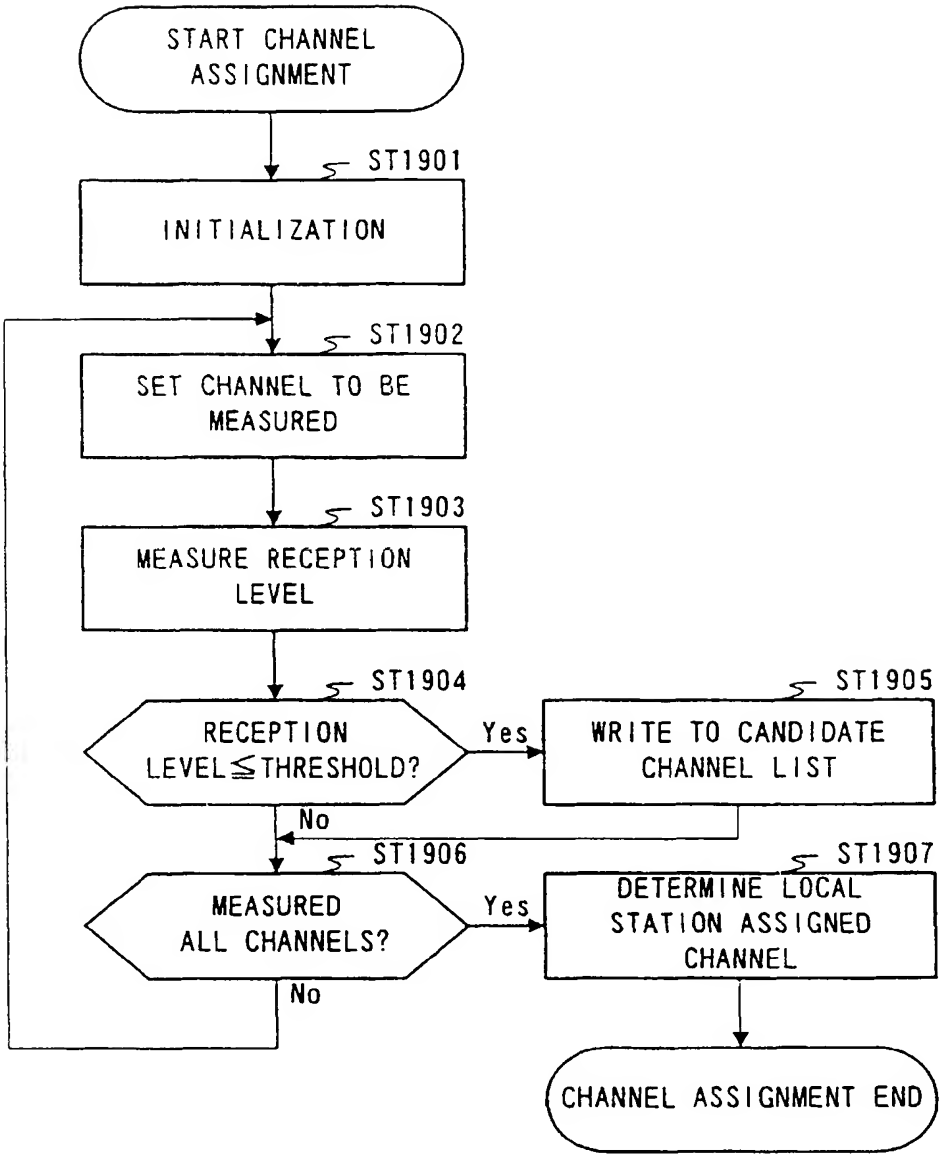


FIG. 19



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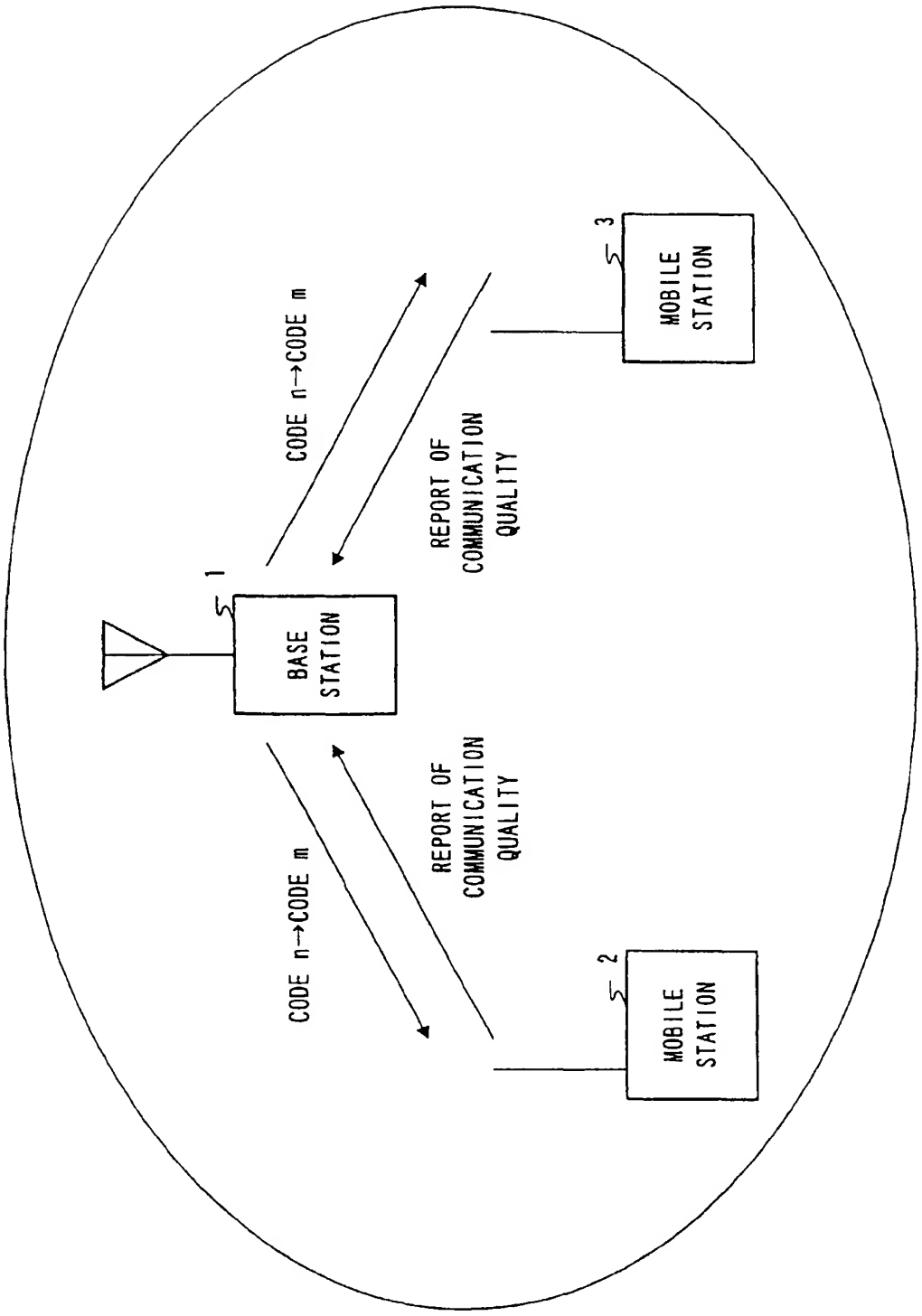


FIG. 20



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## (54) CDMA base station apparatus and code assignment method

(57) Code reading section (44) reads code specification information stored in all code list (42) and interference level measuring section (30) measures the interference level of each code, threshold determination section (45) selects the code specification information whose interference level is smaller than a preset threshold and stores it in code candidate list (43) and code determination section (46) determines the code specification information of said station from the selected code specification information pieces. When adding a new base station, this makes it possible to automatically determine said station code, eliminating the need for theoretical design for assigning codes to all base stations.

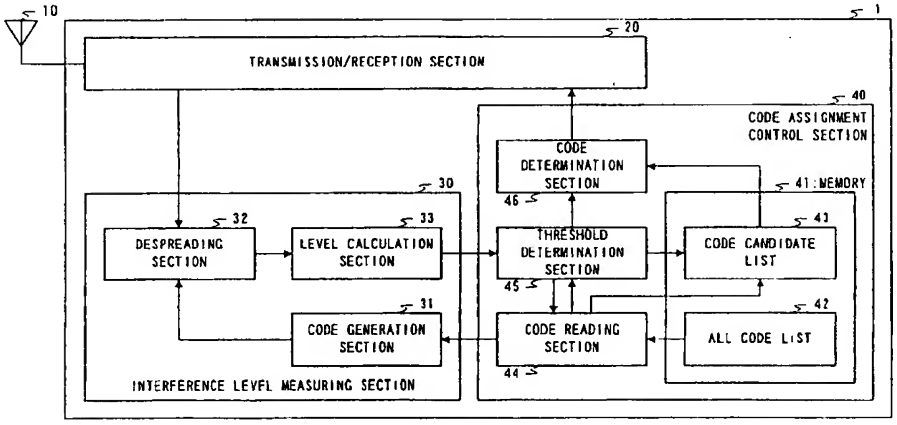


FIG. 1

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# EUROPEAN SEARCH REPORT

Application Number
EP 99 11 8409

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| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H04B
H04Q

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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| MUNICH | 11 March 2003 | Ricciardi, M |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 11 8409

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